7.0
Water Resources

Water is essential to every living creature. Rivers, streams, lakes, and reservoirs provide drinking water, transportation, recreation, and irrigation. These same waters also provide habitat for an abundance of aquatic and amphibious wildlife. Virginia borders one of the nation's most precious water resources, the Chesapeake Bay. The Chesapeake Bay drainage basin encompasses approximately 64,000 square miles and includes portions of Virginia, West Virginia, Maryland, Delaware, Pennsylvania and New York (Figure 2.1). Due in part to its location on the Chesapeake Bay, Virginia is endowed with more than 5,242 miles of tidal shoreline encompassing 2,300 square miles of surface water covering 1,472,000 acres of state-owned bottomlands. These submerged lands harbor Chesapeake Bay grasses, and provide habitat for oysters, shellfish, crabs, and finfish. Along the fringes of the myriad of coves, creeks, rivers and bays of the Chesapeake estuary grow some 225,000 acres of vegetated tidal wetlands. These vegetated areas constitute a vital spawning and nursery area for fish and shellfish, and are an important element of the marine food webs for many economically valuable marine resources of Virginia (Virginia Marine Resources Commission, 2000).

Waters on Department of Defense (DoD) lands throughout the U.S. are fundamental to maintaining the military mission and quality of life for soldiers. DoD uses water resources for amphibious training, water purification training, recreation, and often as a drinking water supply. High water quality is necessary for all of these activities.

Water quality is vulnerable to a variety of human-related and naturally occurring activities. In the Chesapeake Bay watershed, water quality is commonly affected by the following:

- Sedimentation caused by development, shoreline erosion along unbuffered waterways, and poor stormwater volume controls
- Nutrient over-enrichment caused by animal waste runoff, combined sewer overflows, and overfertilization
- Toxics contamination caused by industrial and urban runoff and spills
- Lowered oxygen caused by increased water temperatures in unbuffered waterways and high algal blooms from nutrient over-enrichment.

The effects of such impacts can include elimination of anadromous fish migration, loss of pollution-sensitive aquatic species, fish kills, disease outbreaks, and the establishment and spread of invasive exotic organisms.

The Chesapeake Bay Program has recognized watershed management as the means to restoring water quality in the Chesapeake Bay. Watershed management considers all activities occurring within the area that drains to a waterway, and seeks to balance/manage the activities to enhance or maintain water quality. Common activities associated with watershed management include

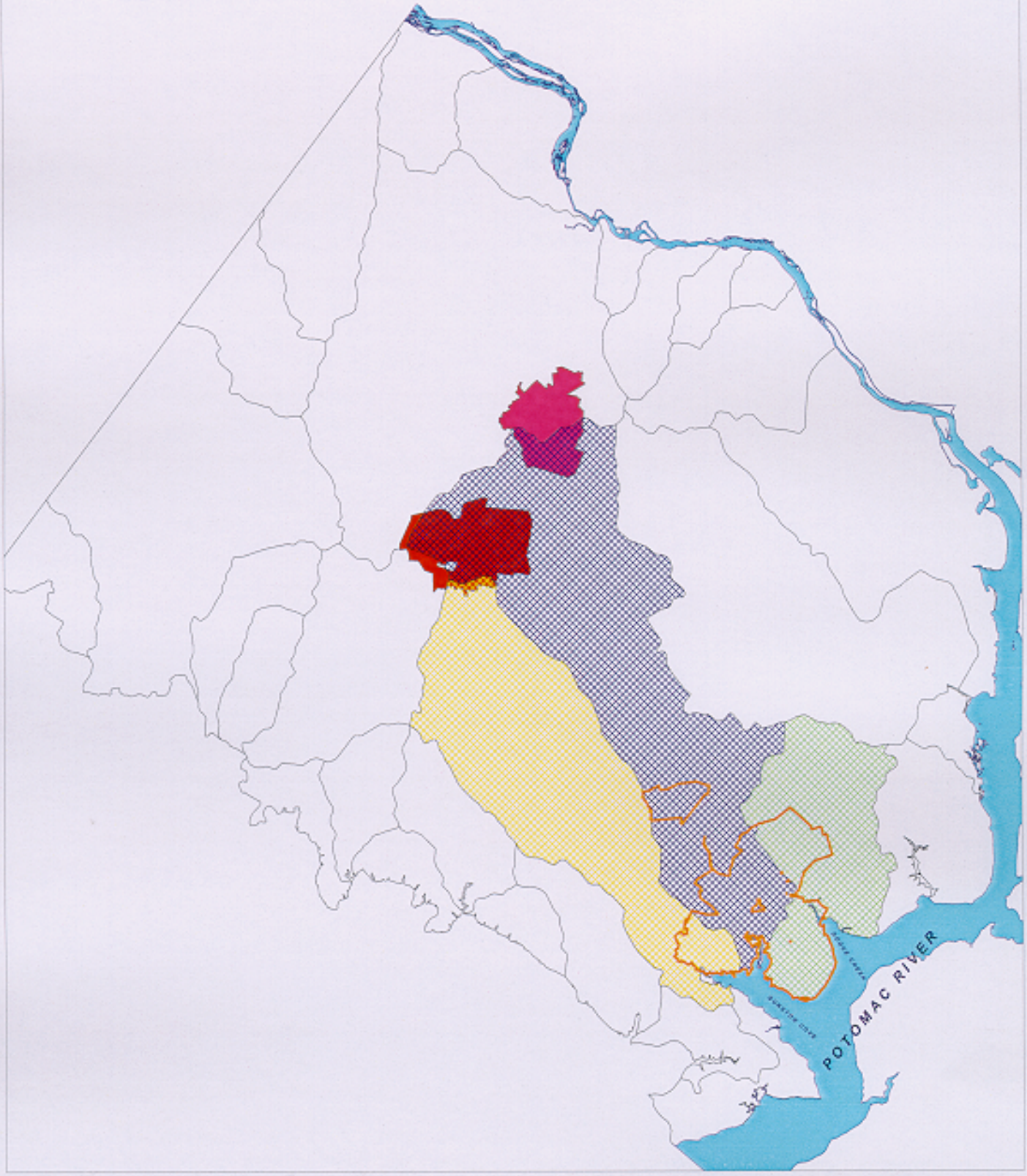
improving stormwater management practices, maintaining vegetated buffers along riparian areas, stabilizing shorelines, and educating developers on environmentally sensitive site design.

DoD and the Department of the Army (DA) became a partner in watershed management in the Chesapeake Bay by signing the commitments outlined in the Chesapeake Bay Program and federal agencies' agreements (U.S. DoD, 1998). DoD and DA recognize that the waters on its lands play a multi-faceted role in maintaining military readiness, quality of life, and ecosystem integrity. Army posts throughout the U.S. are beginning to follow the lead of the installations in the Chesapeake Bay watershed by implementing a watershed approach to land management.

In Fairfax County, efforts to protect water resources have primarily focused on controlling stormwater flows and preventing/correcting associated impacts to aquatic systems (e.g., stream bed and bank scour, erosion and bank undercutting, thermal loading, in-stream blockages to fish migration, and displacement of natural habitat by engineered stabilization structures). Despite Fairfax County's efforts, the rate of development in the County, combined with polluted runoff from roads and nutrient-enriched runoff from yards, continues to degrade water quality in some waterways. Water entering Fort Belvoir in Accotink, Dogue and Pohick Creeks has already been affected by upstream land uses in the Fairfax County area. Fort Belvoir's location at the discharge points of these three drainages makes the installation vulnerable to water quality and hydrologic impacts from land-use patterns and practices outside of its control. Fort Belvoir is meeting the challenge of maintaining and improving water quality in these creeks by managing its land and resources on a watershed level.

Fort Belvoir is located on the Potomac River, the second largest tributary of the Chesapeake Bay, and within the lower reaches of three major tributaries to the Potomac: Accotink Creek, Dogue Creek and Pohick Creek (Figure 7.1). Accotink Creek, at a point five miles upstream from Fort Belvoir's EPG, was included in the U.S. Geological Survey's 1992-1996 National Water-Quality Assessment (NAWQA) for the Potomac River Basin (Ator et al., 1998). NAWQA is a national program that began in 1991 to focus on the water quality of more than 50 major river basins. The NAWQA study concluded that concentrations of nutrients and pesticides in streams of the Potomac River Basin are among the highest in the nation, and are generally related to urban or agricultural land in the contributing watersheds. Overall, the results of the NAWQA Program indicate that Accotink Creek above Fort Belvoir is significantly impacted by urbanization (Ator et al., 1998). Dogue Creek and Pohick Creek, while not included in the NAWQA study, could be expected to have similar types of impacts, although not necessarily to the same degree. Pohick Creek in the vicinity of Fort Belvoir has an additional major source of potential impact – the Norman M. Cole, Jr. Pollution Control Plant, which handles about half of all of the sewage from Fairfax County.

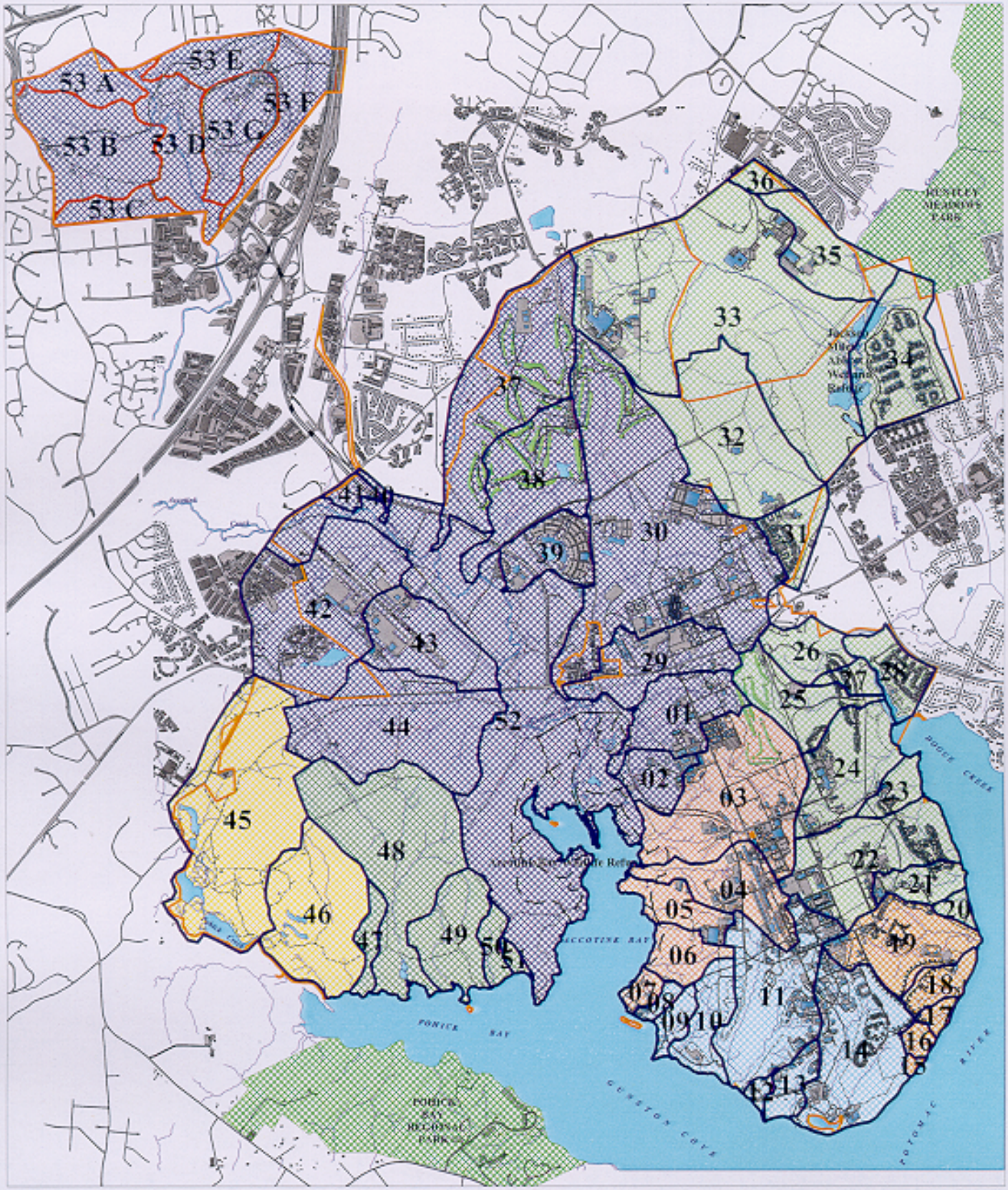
The water resources survey results for Fort Belvoir indicate that the aquatic systems on and through Fort Belvoir, while impacted by urbanization, possess significant aquatic resources with high conservation priority. One of Fort Belvoir's seven watersheds, the Pohick Bay watershed, is nearly unimpacted by urbanization (Figure 7.2). This watershed possesses significant natural resources with high conservation priority. Fort Belvoir's Pohick Bay watershed consists of four subwatersheds: subwatersheds 47, 48, 49, 50, and 51. Subwatershed 48, the only subwatershed with a perennial stream, is of special management interest. The stream, locally known as "Butterfly Creek," is intact and considered to be an excellent example of a natural small-order



MAJOR WATERSHEDS ORIGINATING OUTSIDE of FORT BELVOIR

SOURCE: FAIRFAX COUNTY GIS CENTER, 1999

FIGURE: 7.1



Subwatershed Boundaries
Accotink Bay Watershed
Accotink Creek Watershed
Pohick Creek Watershed
Fort Belvoir Boundary
Pohick Bay Watershed (Fort Belvoir's ONLY Intact Watershed)
Dogue Creek Watershed
Potomac River Watershed
Gunston Cove Watershed
01-53 Subwatershed Numbers

N

WATERSHEDS and SUBWATERSHEDS on FORT BELVOIR

SOURCE: LANDGRAF, 1999

FIGURE: 7.2

stream in the Upper Coastal Plain of northern Virginia (Landgraff, 1999). Since such high-quality watersheds and streams are uncommon in this area of Virginia, subwatershed 48 has been recommended for consideration as a reference stream when looking to improve other similar streams within this region (EA, 2000).

7.1 WATER RESOURCES POLICIES

7.1.1 Federal Water Resources Policy

Fort Belvoir must comply with all federal statutes and regulations regarding water resources, including all fishing regulations. The primary federal law that regulates the protection of water resources is the Clean Water Act (CWA, 33 U.S.C. §1251 et seq.). Two main objectives of the CWA are to:

- Prohibit discharges of pollutants into U.S. navigable waters, except in compliance with a permit.
- Achieve an interim goal of protecting water quality that, wherever attainable, provides for the protection and propagation of shellfish, fish, and wildlife, and provides for recreation in and on the water.

The Phase II Stormwater Regulations under the CWA are the next step in EPA's efforts to preserve, protect, and improve the nation's water resources from polluted stormwater runoff. The Phase II Regulations are intended to further reduce adverse impacts to water quality and aquatic habitat by instituting the use of controls of unregulated sources of stormwater discharges. The Phase II Regulations require additional operators of municipal separate storm sewer systems, or MS4s, and operators of small construction sites, through the use of NPDES permits, to implement programs and practices to control polluted stormwater runoff. The new rule extends coverage of the NPDES stormwater program to small MS4s (serving populations between 1,000 to 100,000) and covers construction sites that disturb between 1 and 5 acres. The term MS4 not only refers to municipally-owned systems, but it also applies to universities and military bases. Small MS4 stormwater management programs must be comprised of six program elements, known as "minimum control measures." These minimum control measures include the following:

- Public education and outreach
- Public participation / involvement
- Illicit discharge detection and elimination
- Construction site runoff control
- Post-construction runoff control
- Pollution prevention / good housekeeping.

Another applicable federal law is the Coastal Zone Management Act (CZMA, 16 U.S.C. §1452, et seq. most recently amended through the Coastal Management Enhancement Act of 1999). The CZMA's goal is "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone…." (§1452[1]). This protection of natural resources includes protection of wetlands, floodplains, estuaries, and fish and wildlife and their habitats, within the coastal zone. Under CZMA, the Coastal Zone Management Program was established. The program is a voluntary partnership between the federal government and U.S. coastal states and territories authorized under the CZMA to preserve, protect, restore, and enhance coastal zone resources.

The CZMA contains a federal consistency requirement, which states that federal actions reasonably likely to affect any land or water use or natural resource of the coastal zone be consistent with the enforceable policies of a coastal state's or territory's federally approved coastal management program. Virginia's federally approved Coastal Resources Management Program focuses on problems associated with polluted runoff, habitat protection, riparian buffers, wetlands, fisheries, sustainable development, waterfront redevelopment, septic systems, and erosion and sediment control. Virginia's coastal zone encompasses the eastern third of the state including the Chesapeake Bay and its tributary rivers.

One-hundred-year floodplains on Fort Belvoir are also protected under Executive Order 11988, *Floodplain Management* (May 24, 1977). Under this order, Fort Belvoir is required to evaluate potential effects of any action occurring in a floodplain.

The Chesapeake Bay Restoration Act of 2000 amends the Federal Water Pollution Control Act to assist in the restoration of the Chesapeake Bay. The Chesapeake Bay Restoration Act of 2000 requires federal agencies that own or operate a facility within the Chesapeake Bay watershed to participate in regional and subwatershed planning and restoration programs. In addition, the Act requires federal agencies that own or occupy real property in the Chesapeake Bay watershed to ensure that the property, and actions taken with respect to the property, comply with the Chesapeake Bay Agreement, the *Federal Agencies Chesapeake Ecosystem Unified Plan*, and any subsequent agreements and plans (Section 7.1.6).

The primary federal regulation guiding fish conservation on military lands is the Sikes Act (16 USC 670a) and the Sikes Act Amendments of 1997 (Title XXIX) (together known as Sikes Act). The act authorizes the Secretary of Defense to (1) carry out a program for the conservation and rehabilitation[1] of natural resources on military installations, and (2) prepare an Integrated Natural Resources Management Plan (INRMP) in cooperation with the USFWS and state fish and wildlife agencies[2]. The Sikes Act requires the INRMP to "… reflect the mutual agreement of

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[1] Conservation and rehabilitation is defined as "…to utilize those methods and procedures to the maximum extent practicable on public lands subject to this subchapter consistent with any overall land use and management plans for the lands involved. Such methods and procedures shall include, but shall not be limited to, all activities associated with scientific resources management such as protection, research, census, law enforcement, habitat management, propagation, live trapping and transplantation, and regulated taking in conformance with the provisions of this subchapter."

[2] State fish and wildlife agencies are defined as "… the one or more agencies of State government that are responsible under State law for managing fish or wildlife resources."

the parties [USFWS and state fish and wildlife agencies] concerning conservation, protection, and management of fish and wildlife resources." Excerpts from the Sikes Act regarding fish and wildlife management are contained in Section 11.1.1. Other federal regulations that combine fish with wildlife resources are also discussed in Section 11.1.1. Federal threatened and endangered species laws are discussed in Section 12.1.1.

The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 USC 4701 et seq.) establishes the federal program, including the Aquatic Nuisance Species Task Force, to prevent the introduction and spread of aquatic nuisance species.

7.1.2 State Water Resources Policy

Virginia has promulgated a number of laws and regulations for the protection of water resources, including fish. Much of the charge for ensuring that Virginia's water resources are responsibly used rests with the Virginia Marine Resources Commission, operating under the mandates of Virginia's Wetlands and Subaqueous Laws. The Code of Virginia vests ownership of "all the beds of the bays, rivers, creeks, and shores of the sea in the Commonwealth to be used as a common by all the people of Virginia" (VMRC, 2000). In 1982, the Virginia General Assembly enacted a revised Wetlands Law which brought non-vegetated shoreline between mean low and mean high water under state or local jurisdiction, as well as the vegetated shoreline brought under protection in 1972 (VMRC, 2000).

The Virginia Chesapeake Bay Preservation Act (CBPA, §10.1-2100, et seq., of the Code of Virginia) was enacted to protect the Chesapeake Bay from further degradation due to nonpoint source pollution and sedimentation. Under the CBPA, Fairfax County adopted a Chesapeake Bay Preservation Ordinance (Chapter 118, Code of the County of Fairfax, Virginia) that protects Resource Protection Areas (RPAs) from most forms of development to preserve their function as biological filters and buffers that protect the water quality of the Chesapeake Bay. RPAs filter stormwater runoff and prevent nutrients, toxics, and sediments from entering streams, rivers, and ultimately the Chesapeake Bay. The Chesapeake Bay Preservation Ordinance defines RPAs as consisting of the following:

- A tidal wetland or tidal shore
- A nontidal wetland connected by surface flow and contiguous to a tidal wetland or tributary stream
- A tributary stream
- Any buffer area as follows:
  - Any land within a major floodplain
  - Any land within 100 feet of a tidal shore, a tidal wetland, or a nontidal wetland connected by surface flow and contiguous to a tidal wetland or tributary stream
  - Any land within 100 feet of a tributary stream (§118-1-7 of the Fairfax County Code).

On Fort Belvoir, the 100-year floodplains of Dogue Creek, Accotink Creek, and the Potomac River are considered to be buffer areas, and therefore are RPAs under the Virginia CBPA (Figure 4.2*)*. Water-dependent development and redevelopment are allowed within RPAs (§118-2-1 of the Fairfax County Code), subject to compliance with additional criteria (§118-3-2 of the Fairfax County Code). Exemptions to the ordinance include existing facilities, maintenance of public utilities, water wells, site amenities for passive recreation, historic preservation activities, and archeological activities (§118-5-1, §118-5-2, and §118-5-3 of the Fairfax County Code).

The Virginia Department of Game and Inland Fisheries (VDGIF) is the policy-making entity responsible for conserving, protecting, and replenishing the supply of game, nongame wildlife, and fish of the Commonwealth of Virginia (Virginia Administrative Code, 4 VAC15). Under the wildlife permit program (§29.1-417 of the Code of Virginia) VDGIF must be consulted regarding capture, hold, propagation, and disposal of fish and wildlife. Other state regulations that discuss fish and wildlife management jointly are covered in Section 11.1.2. Virginia rare, threatened, and endangered species laws are discussed in Section 12.1.2.

Other Virginia water resource laws include the following:

- Virginia Water Control Law (§62.1-44.2 of the Code of Virginia) mandates the protection of existing high quality state waters and the restoration of all other state waters to such quality as to permit reasonable public uses and to support aquatic life.

- Virginia Water Quality Standards (Virginia Administrative Code, 9 VAC 25-260) are water quality requirements that implement the Water Control Law.

- Virginia Water Quality Improvement Act (§10.1-2117 through 2134 of the Code of Virginia) establishes a fund aimed at reducing point source nutrient loadings to the Chesapeake Bay.

- Virginia Water Protection Regulations (Virginia Regulations, VR 680-15-02) establishes permits for regulating activities affecting state water quality.

- The Virginia Stormwater Management Act (§62.1-44.15 through 44.30 of the Code of Virginia) allows local governments to regulate the control and treatment of stormwater runoff to prevent flooding and contamination of local waterways.

- The Surface Water Management Act of 1989 (§62.1-242 et seq. of the Code of Virginia) regulates surface water usage to ensure that adequate surface flow of water in streams is maintained to support a variety of uses, including support of aquatic and other water-dependent wildlife.

- The Ground Water Management Act of 1992 (§62.1-254 et seq. of the Code of Virginia) regulates the usage of ground water in certain areas.

- Virginia Pollution Abatement permits for stored or recycled wastewater.

- Virginia Pollutant Discharge Elimination System permit for all point source discharges, including ditches and stormwater pipes, to surface waters.

- Virginia Water Protection permit (Section 401 certification) for discharges of dredged material into waterways or wetlands, or for other instream activities.

- Corrective Action Plan permits for the cleanup of underground storage tanks leaks.

- Virginia Water Protection Permit (§62.1-44.15:5 of the Code of Virginia), for the preservation of instream flows for purposes of protecting, among other things, fish and wildlife resources and habitat.

- *Virginia Acts of Assembly* Chapters 1054 (House) and 1032 (Senate), passed in the 2000 session, amends existing wetland laws to require a Virginia Water Protection Permit from the Water Control Board for certain activities in non-tidal wetlands.

7.1.3 Department of Defense Water Resources Policy

DoD's natural resources management policy is contained within DoDI 4715.3, *Environmental Conservation Program*. This instruction requires installations to follow an ecosystem-based approach to natural resources management, to inventory and protect important biological resources, and to promote biodiversity. The instruction also allows for multiple uses of an installation's natural resources, and for public access to these resources for recreation, education and scientific research and study, compatible with the installation's ecosystem management goals. Excerpts from DoDI 4715.3 that are applicable to water resources management are presented below. Excerpts from DoDI 4715.3 that combine fish with wildlife resources are discussed in Section 11.1.3. Excerpts pertaining to threatened and endangered species are presented in Section 12.1.3.

Excerpts from DODI 4715.3
Select Provisions Applicable to Water Resources

- All DoD conservation programs shall work to guarantee continued access to our land, air, and water resources for realistic military training and testing while ensuring that the natural and cultural resources entrusted to DoD care are sustained in a healthy condition for scientific research, education, and other compatible uses by future generations. (D1a)

- The principal purpose of DoD lands and waters is to support mission-related activities. Those lands and waters shall be made available to the public for educational or recreational use of natural and cultural resources when such access is compatible with military mission activities, ecosystem sustainability, and with other considerations such as security. (D1d)

- Natural resources under the stewardship and control of DoD shall be managed to support and be consistent with the military mission, while protecting and enhancing those resources for multiple use, sustainable yield, and biological integrity. Land use practices and decision shall be based on scientifically sound conservation procedures and techniques, and use scientific methods and an ecosystem approach. (D2a)

Excerpts from DODI 4715.3 Select Provisions Applicable to Water Resources
(continued)
■ Biologically or geographically significant or sensitive natural resources (e.g., wetlands, forests, floodplains, watersheds, estuaries, riparian areas, coastal barrier islands, marine sanctuaries, critical habitats, animal migration corridors) or species (e.g., threatened or endangered species, certain marine mammals, and migratory birds) shall be inventoried and managed to protect these resources, and to promote biodiversity, using the goals identified in paragraph F1a. (D2c)
■ Best management practices shall be used to minimize nonpoint sources of water pollution. DoD actions that might cause nonpoint source pollution shall be consistent with 32 U.S.C. 1251 et seq. (D2f)
■ DoD operations, activities, projects, and programs that affect the land, water, or natural resources of any coastal zone shall be consistent with Sections 1451 et seq., and 1431 et seq. of 16 U.S.C. (D2g)
■ Adverse impacts on floodplains shall be avoided when possible. The direct or indirect support of floodplain development shall be avoided where there is a practicable alternative. (E.O. 11988) (D2k)
■ Portions of installation real property that have significant ecological, cultural, scenic, recreational, or educational value may be set aside for conservation of those resources, where such conservation is consistent with the military mission. (F1j)

7.1.4 Department of the Army Water Resources Policy

The Army's natural resources management policy is contained within AR 200-3, *Natural Resources–Land, Forest and Wildlife Management*. This regulation establishes the Army's requirements for managing and using water resources in accordance with the principles of ecosystem management, and institutes the Army's commitment to conserve, protect, and sustain biological diversity, and to restore degraded ecosystems. AR 200-3 addresses sediment and erosion control, federal actions in or affecting a coastal zone, the protection of aquatic resources, and access to water areas suitable for recreational use. AR 200-3 also establishes the Army's commitment to provide sustained multiple use of, and public access to, natural resources. Excerpts from AR 200-3 that are applicable to water resources management are presented below. AR 200-3 addresses fish and wildlife management requirements together. Excerpts of AR 200-3 addressing fish and wildlife are presented in Section 11.1.4. Excerpts from AR 200-3 regarding threatened and endangered species are discussed in Section 12.1.4.

Excerpts from AR 200-3 Select Sections Applicable to Water Resources
■ Installation commanders will provide for controlled recreational access at Department of the Army (DA) installations and facilities containing land and water areas suitable for the recreational use and enjoyment of the public. (2-10a1)

Excerpts from AR 200-3
Select Sections Applicable to Water Resources

(continued)

- Installation sources of dust, runoff, silt and erosion debris will be controlled to prevent damage to land, water resources, equipment, and facilities, including adjacent properties. An erosion and sedimentation control plan must be implemented where appropriate. A protective vegetative cover will be maintained over all compatible areas… In order to minimize land maintenance expenditure and help ensure environmental compliance, physically intensive land disturbing activities should be sited on the least erodible lands … The potential erodibility of a site (as diagnosed from existing soil types, slopes and vegetative cover), and the location of adjacent wetlands will be identified and analyzed in all prepared plans for development, training, as well as other land uses…(2-15)

- [F]ederal actions in or affecting a coastal zone must, to the maximum extent practicable, be consistent with that State's Coastal Zone Management Plan. (2-19)

- It is DA policy to avoid adverse impacts to existing aquatic resources and offset those adverse impacts which are unavoidable. (2-21b)

- The natural resources management professional will be an active participant in all planning and decision making activities regarding uses of the land to ensure that current and planned mission activities (for example, master planning, construction requests, site approval requests, and training exercise plans) are conducted in a manner which is compatible with natural resources and other environmental requirements. (3-2b)

- Whenever practicable, Army lands with suitable natural resources will be managed to allow for outdoor recreational opportunities. (7-1a). AR 200-3 defines "Outdoor Recreation" as follows: "Recreational program, activity, or opportunity that is dependent on the natural environment. Examples are hunting, fishing, trapping, picnicking, bird-watching, off-road vehicle use, hiking and interpretive trails use, wildlife and scenic river use, and underdeveloped camping areas. Developed or constructed activities such as golf courses, lodging facilities, boat launching ramps, and marinas are not included."

- All land and water areas will be closed to off-road recreational use by motorized [off-road vehicles] except those areas and trails which are determined suitable and specifically designated for such under the procedures established in this regulation. (8-1b) When ORV use is permitted, the intensity, timing, and distribution will be carefully regulated to protect the environmental values. In designating suitable sites, equitable treatment should be given to all forms of outdoor recreational activity and, where possible, nonconflicting use will be encouraged on existing trails. Prior to designating such areas or trails for ORV use, the environmental consequences must be assessed and environmental statements prepared and processed when such assessments indicated that the proposed use will create a significant environmental impact or be environmentally controversial. (8-1c). AR 200-3 defines ORVs as "A vehicle designed for travel on natural terrain. The term excludes a registered motorboat confined to use on open water and a military, emergency, or law enforcement vehicle during use by an employee or agent of the Government or one of its contractors in the course of employment or agency representation." Note the definition is not limited to "motorized" vehicles. Without such restriction, this INRMP considers ORVs to include both motorized and non-motorized vehicles.

7.1.5 Fort Belvoir Water Resources Policy

Fort Belvoir's installation-specific natural resources management policies are contained within the Fort Belvoir Supplement to AR 200-3 (dated February 20, 1996) (Appendix H). This installation regulation includes specific restrictions aimed at protecting installation land and water resources from impact. Excerpts from the Fort Belvoir Supplement to AR 200-3 relevant to water resources are presented below. Fort Belvoir's Supplement to AR 200-3 combines fish with wildlife resources. Excerpts from the supplement regarding fish and wildlife resources are presented in Section 11.1.5.

- "Fisherman and boaters are required to provide for environmental protection of all shoreline areas through restricting watercraft launching to designated marina launch facilities. Streamside clearing, littering, parking in other than designated areas, and driving of privately owned vehicles (POVs) off primary installation roads are prohibited." (6-2f3)

- "Off-road vehicles (ORV), which include, but are not limited to, motorized all-terrain vehicles, snow mobiles and dirt bikes, may not be operated on Fort Belvoir. Bicycles, which include but are not limited to all-terrain bikes and mountain bikes, are not permitted off paved roadways or off paved bike trails, unless otherwise approved by DIS." (8-1g)

- "Privately owned watercraft, which include, but are not limited to, motorboats, personal watercraft, sailboats, canoes, rowboats, kayaks, and inflatable watercraft, must be launched at designated areas. All watercraft, with the exception of wind-board surfers, must be launched at the marina launch facility, unless otherwise approved by DIS… No watercraft shall be launched or landed within the wildlife refuges, unless otherwise approved by DIS." (8-1i)

Fort Belvoir Regulation 210-27, *Range Procedures and Utilization of Training Areas*, provides specific requirements for environmental protection and conservation of training areas. It requires that vehicles stay on established trails and roads, restricts riot control agents to specified training areas to minimize environmental damage, and requires that all waste be removed from the training areas and disposed of properly. The regulation also requires ENRD review of all land disturbing activities (U.S. Army, 1994).

7.1.6 Chesapeake Bay Program

Since 1983, the Chesapeake Bay Program (CBP), a cooperative, voluntary program comprised of federal, state, and local agencies, has been working toward the restoration and protection of the Chesapeake Bay. The 1987 *Chesapeake Bay Agreement* set forth specific goals in a number of areas, including water quality. In 1990, DoD and the Environmental Protection Agency signed the *Cooperative Agreement Between DoD and EPA Concerning Chesapeake Bay Activities*, which incorporated the goals of the 1987 agreement and increased cooperation between DoD and other CBP partners. This 1990 agreement was refined in 1993 with the *DoD/EPA Action Items for the Chesapeake Bay Program*. In 1994, 29 federal agencies, including DoD and the Department of the Army, signed the *Agreement of Federal Agencies on Ecosystem Management in the Chesapeake Bay* to commit to manage the Chesapeake Bay watershed as a cohesive

ecosystem, and recommit to work together with the states and other parties to achieve the goals of the 1987 *Chesapeake Bay Agreement*. The major commitment areas in this agreement include partnership, research, data coordination, habitat restoration, nutrient reduction, toxics reduction, and national service. In 1998, in response to the 1998 *Clean Water Action Plan*, federal agencies signed the *Federal Agencies Chesapeake Ecosystem Unified Plan (FACEUP)* to build upon the achievements of the 1994 federal agencies agreement, consistent with the federal agencies' missions and success in securing the necessary resources. Among the water resources-related commitments in *FACEUP* is a call for federal agencies to carry out voluntary stormwater management actions and to encourage construction design that adopts low impact development design and best management practices (BMPs) for stormwater management, as well as sediment and erosion control. Most recently, the Chesapeake Bay Program partners signed a new Bay agreement designed to renew the historically significant 1987 agreement. This new agreement, *Chesapeake 2000*, guides the Chesapeake Bay Program partnership from 2000 until 2010. Specific CBP directives that pertain to water resources include Directive No. 93-1, *Joint Tributary Strategy Statement*; Directive No. 93-4, *Fish Passage Goals*; Directive No. 97-1, *Baywide Nutrient Reduction Progress and Future Directions*; and Directive No. 97-3, *Community Watershed Initiative*.

Fort Belvoir views the 1987 *Chesapeake Bay Agreement*, the *Agreement of Federal Agencies on Ecosystem Management in the Chesapeake Bay, FACEUP*, and *Chesapeake 2000* as the overarching definers of its water resources management program. The agreements consider and integrate all of the forces influencing water resources management through initiatives addressing water quality and living resources. The agreements also embody the recognition of the role of these forces in shaping the condition of the Bay's aquatic resources, and the commitment of all participating agencies, including DoD/DA, to attain specific goals set in the initiatives that together are directed at protecting and restoring the Bay's aquatic resources. The *Chesapeake Bay Agreement*, the *Agreement of Federal Agencies on Ecosystem Management in the Chesapeake Bay, FACEUP*, and *Chesapeake 2000* accomplish this by consolidating existing regulatory requirements, such as water quality protection under the Clean Water Act, and supplementing these regulations with policy and guidance addressing unregulated but nonetheless ecologically significant management considerations, such as vegetation cover and stormwater runoff. In so doing, the agreements effectively guide development of a watershed-based approach to aquatic resources management.

7.1.7 American Heritage Rivers Initiative

President Clinton initiated the American Heritage Rivers Initiative in 1997. The Initiative provides federal assistance to facilities and communities along a designated river to complete projects that will restore and protect the river's natural and cultural resources. The Potomac River was designated an American Heritage River in 1998.

Objectives for the Potomac American Heritage River Initiative (U.S Environmental Protection Agency, 1999) to which Fort Belvoir can contribute include:

- Restoring living resources and historic Potomac fisheries
- Achieving the Chesapeake Bay Program's year 2000 nutrient reduction goals

- Developing more effective flood-loss reduction plans
- Promoting appreciation and development of heritage and recreational assets
- Increasing opportunities to learn about the basin's natural features, history, and cultures.

7.2 BASELINE WATER RESOURCES CONDITIONS

While the term "water resources" is typically applied to aquatic features such as water quality and fish, Fort Belvoir recognizes that such in-stream resources are inextricably linked to land conditions and activities throughout their watersheds. As a result, Fort Belvoir's water resources management program focuses on a combination of watershed management and aquatic (i.e., in-stream) resource management.

7.2.1 Watersheds

7.2.1.1 Watershed Studies

Information on watershed conditions at Fort Belvoir has been obtained through the following two detailed study efforts:

- A comprehensive baseline watershed survey was undertaken to characterize installation waterways and their associated watersheds, to identify existing problems within installation waterways, and to recommend concepts to correct problems. The findings of this watershed survey are reported in *Watershed Delineation Project and Problem Site Descriptions, Including Maps and Photographs* (Landgraf, 1999). The data from this survey have been incorporated into the Fort Belvoir GIS.
- A stream corridor assessment was undertaken to address further the problem conditions identified in the 1999 watershed survey, and to develop management recommendations to correct existing problems and prevent future problems. The results of the stream corridor assessment, including management recommendations, are reported in *Watershed-based Stream Corridor Management and Protection, Fort Belvoir, Virginia* prepared by the U.S. Army Corps of Engineers Waterways Experiment Station (Allen et al., 1999). This report presents a planned approach to stormwater management; erosion control; water quality management; riparian buffer restoration, maintenance and protection; and fish and wildlife habitat protection and restoration. The report addresses specific types of stream corridor problems, describes solutions, and provides overall recommendations and action items to conserve, enhance, and restore ecological conditions within stream corridors, and prevent future problems.

7.2.1.2 Watershed Conditions

The baseline watershed survey (Landgraf, 1999) identified seven main watersheds on Fort Belvoir (Figure 7.2 and Table 7.1). Fort Belvoir's three largest watersheds originate off-post: the Accotink Creek watershed, the Dogue Creek watershed, and the Pohick Creek watershed. The majority of water from within installation boundaries flows into these three watersheds. The

remaining installation areas that do not drain to the three major creeks belong to four smaller on-post watersheds: the Accotink Bay watershed, the Pohick Bay watershed, the Gunston Cove watershed, and the Potomac River watershed. These watersheds drain directly into these four waterbodies without first entering Accotink Creek, Dogue Creek, or Pohick Creek. The baseline watershed survey further delineated Fort Belvoir's seven main watersheds into 53 subwatersheds (Figure 7.2). The following text presents summary descriptions of Fort Belvoir's seven main watersheds (Landgraf, 1999).

Table 7.1: Fort Belvoir Major Watershed Survey – Summary

Watershed	*Size (acres)*	*Impervious Surface (%)*	*Forest (%)*	*Open Area (%)*	*Wetland (%)*
Accotink Creek	4,514.66	10.11	63.06	28.06	13.49
Dogue Creek	2,334.83	11.40	65.99	22.65	17.78
Pohick Creek	698.91	0.50	94.96	4.24	19.97
Gunston Cove	680.57	16.49	51.85	31.66	2.98
Accotink Bay	603.91	18.58	45.35	42.13	4.42
Pohick Bay	565.68	0.01	93.46	6.54	5.50
Potomac River	236.61	14.24	59.62	26.15	4.34

Source: Landgraf, 1999 updated with information from the 2000 Watershed Update.

Accotink Creek

The Accotink Creek watershed is the largest watershed on the installation. Its total acreage on Fort Belvoir, including EPG, is 4,515 acres. The area is comprised of 14 subwatersheds (Figure 7.2, Table 7.2), 13 of which lie within the Main Post and one consisting of EPG. Accotink Creek and its tributaries flow through the central portion of the installation, draining 3,707 acres, or 44%, of the Main Post. Forests cover 63.06% of Accotink Creek watershed on Fort Belvoir. The Accotink Creek watershed contains the third highest percentage of wetlands (13.49%) on the installation (Landgraf, 1999).

Table 7.2: Fort Belvoir Watershed Survey – Accotink Creek

Subwatershed	*Size (acres)*	*Impervious Surface Acres (%)*		*Forest Acres (%)*		*Open Area Acres (%)*		*Wetland Acres (%)*	
1	133.22	19.82	(14.9)	71.37	(53.57)	42.03	(31.55)	8.81	(6.61)
2	62.43	12.63	(20.2)	38.43	(61.56)	11.37	(18.21)	11.54	(18.48)
29	147.83	37.91	(25.6)	53.47	(36.17)	56.44	(38.18)	8.87	(6.01)
30	699.63	121.15	(17.3)	296.81	(42.42)	281.67	(40.26)	23.02	(3.29)
37	344.14	20.97	(6.1)	255.66	(74.29)	65.51	(19.04)	9.73	(2.83)
38	205.97	9.77	(4.8)	85.16	(41.35)	111.04	(53.91)	15.93	(7.73)
39	97.97	45.28	(46.2)	11.02	(11.25)	41.67	(42.53)	1.43	(1.46)
40	7.68	0.83	(10.8)	1.87	(24.35)	4.98	(64.84)	1.13	(14.71)
41	21.20	5.59	(26.4)	7.87	(37.14)	7.73	(36.48)	5.86	(27.65)
42	352.08	55.10	(15.6)	171.33	(48.66)	113.65	(32.28)	33.58	(9.54)
43	154.93	35.63	(23.0)	44.89	(28.97)	92.41	(48.03)	1.77	(1.14)

Table 7.2: Fort Belvoir Watershed Survey – Accotink Creek									
Subwatershed	***Size (acres)***	***Impervious Surface Acres (%)***		***Forest Acres (%)***		***Open Area Acres (%)***		***Wetland Acres (%)***	
(continued)									
44	329.93	7.91	(2.4)	266.85	(80.88)	55.17	(16.72)	10.67	(3.23)
52	1,150.95	32.79	(2.9)	920.60	(79.99)	197.56	(17.16)	451.04	(39.19)
53	806.70	51.02	(6.3)	621.19	(77.00)	185.51	(23.00)	25.71	(3.19)
Total*	**4,514.66**	**456.40**	**(10.11)**	**2846.52**	**(63.06)**	**1266.74**	**(28.06)**	**609.09**	**(13.49)**

Source: Landgraf, 1999 updated with information from the 2000 Watershed Update.

*Total acreages (and percentages) under each land use/land cover category (i.e., impervious, forest, open area, and wetland) do not combine to equal the total acreage (100%) for the watershed because some areas of overlap exist.

Fort Belvoir encompasses 13.6% of the entire 33,156 acres of the Accotink Creek watershed. The watershed is the second largest in Fairfax County, and is about 80 to 85% developed above the installation. Fort Belvoir's portion of the Accotink Creek watershed is relatively undeveloped, containing only 10.11% impervious surface. The headwaters of Accotink Creek originate east of the City of Fairfax and just south of the City of Vienna (Figure 7.1), with tidal influence extending to the U.S. Route 1 crossing. The Cities of Fairfax and Vienna are two of the most densely populated areas in all of Fairfax County. Above Fort Belvoir, Accotink Creek is impounded at Lake Accotink, and then again at several unnamed ponds (Landgraf, 1999).

Within the past 5 years, major development activity within the subwatersheds of Accotink Creek on Fort Belvoir have changed the flow regimes of the watershed. Recent development in the watershed on post is concentrated in the area north of U.S. Route 1 and includes new/expanded facilities at the Davison Army Airfield, expanded North Post Golf Course facilities, new administrative buildings, and new industrial facilities. The newly constructed Fairfax County Parkway has artificially increased the width/depth ratio of four streams that flow into Accotink Creek. On Fort Belvoir, the construction of the Headquarters Defense Logistics Agency building has increased the impervious surface within subwatershed 39 by approximately 800%. This large area of impervious surface largely exists on the building's expansive parking lot. The widening of Telegraph Road at Beulah Street (increase to four-lane divided road with turning lanes and multipurpose trails), and the construction of the new Fairfax County Parkway have increased the impervious surface within subwatersheds 37, 40, and 41. The widening of the remainder of Telegraph Road through Fort Belvoir will also impact these three subwatersheds and subwatershed 42 of Accotink Creek. The future widening of U.S. Route 1 (proposed increase from a four-lane undivided road to a six-lane divided road with turning lanes and multi-purpose trails) will impact subwatersheds 29, 30, 42, 44, 52 of Accotink Creek. These future road widenings will increase the percentage of impervious area and decrease the forest acreage along the road edge. The impacts to these subwatersheds will be increased runoff and subsequent increased stream flow volume, both of which contribute to the instability of stream channels, and attendant degradation of water quality and riparian lands (Landgraf, 1999).

Dogue Creek

The northeast portion of Fort Belvoir is in the Dogue Creek watershed, the second largest watershed on the installation. The Dogue Creek watershed has 15 subwatersheds, all of which are on the Main Post (Figure 7.2, Table 7.3). Fort Belvoir covers slightly more than one-fifth (2,335 acres) of the Dogue Creek watershed in Fairfax County (10,883 acres). The Dogue Creek watershed has the second highest percentage of wetlands (17.78%) on the installation, including large wetland areas in the Jackson Miles Abbott Wetland Refuge (JMAWR), that help reduce storm flow velocities. Impervious surfaces cover 11.40% of the Dogue Creek watershed on Fort Belvoir, and forests cover 65.99% (Landgraf, 1999).

Table 7.3: Fort Belvoir Watershed Survey – Dogue Creek

Subwatershed	*Size (acres)*	*Impervious Surface Acres (%)*		*Forest Acres (%)*		*Open Area Acres (%)*		*Wetland Acres (%)*	
20	16.82	0.46	(2.7)	12.39	(73.66)	3.97	(23.61)	0.76	(4.52)
21	54.22	8.61	(15.9)	27.74	(51.16)	17.87	(32.96)	2.22	(4.09)
22	217.74	45.99	(21.1)	84.51	(38.81)	87.25	(40.07)	12.17	(5.59)
23	40.72	3.94	(9.7)	30.87	(75.81)	5.91	(14.51)	6.22	(15.28)
24	161.99	29.72	(18.3)	89.98	(55.55)	42.29	(26.11)	11.74	(7.25)
25	113.35	15.61	(13.8)	39.79	(35.11)	57.95	(51.12)	3.93	(3.47)
26	72.61	6.40	(8.8)	35.02	(48.23)	31.19	(42.96)	7.72	(10.63)
27	26.89	4.90	(18.2)	9.76	(36.31)	12.23	(45.48)	7.08	(26.33)
28	72.47	14.96	(20.6)	16.57	(22.86)	40.94	(56.49)	19.38	(26.74)
31	68.95	14.10	(20.4)	39.65	(57.51)	15.21	(22.04)	0.37	(0.54)
32	302.28	16.12	(5.3)	258.71	(85.58)	27.46	(9.08)	18.35	(6.07)
33	830.69	58.91	(7.1)	704.77	(84.84)	67.02	(8.07)	223.75	(26.94)
34	202.62	33.40	(16.5)	76.36	(37.69)	92.86	(45.83)	46.71	(23.05)
35	130.29	11.53	(8.8)	97.03	(74.47)	21.73	(16.68)	47.31	(36.31)
36	23.19	0.77	(3.3)	17.56	(75.72)	4.86	(20.96)	7.41	(31.91)
Total*	**2334.83**	**265.42**	**(11.40)**	**1540.71**	**(65.99)**	**528.74**	**(22.65)**	**415.12**	**(17.78)**

Source: Landgraf, 1999.

*Total acreages (and percentages) under each land use/land cover category (i.e., impervious, forest, open area, and wetland) do not combine to equal the total acreage (100%) for the watershed because some areas of overlap exist.

Dogue Creek, the main stream of the watershed, originates in Rose Hill near Franconia Road (Figure 7.1), and is tidal up to the U.S. Route 1 bridge. Huntley Meadows Park, located just upstream of Fort Belvoir in the center of the watershed, contains a large wetland area that acts as a settling basin. Several beaver impoundments exist on Dogue Creek within Huntley Meadows Park (Landgraf, 1999).

The Dogue Creek watershed is currently experiencing the most intense off-post development of the three main Fort Belvoir watersheds. Development is occurring off of Fort Belvoir in the northern portion of the watershed, as well as immediately outside Fort Belvoir near the Walker Gate. Within the last nine years, Kingstowne, a mixed residential and commercial development, has grown to engulf most of the land around the headwaters of Dogue Creek above Fort Belvoir (Landgraf, 1999).

Within the installation, the Dogue Creek watershed contains nine of the twelve housing areas on Fort Belvoir. The housing areas contribute a considerable amount of impervious surface to five subwatersheds (subwatersheds 22, 24, 27, 28, and 31). The high percentage of impervious surface area increases runoff velocities and accelerates downstream erosion. The new Fort Belvoir Elementary School, the Beulah Street / Telegraph Road intersection and realignment, and new construction along Telegraph Road have increased impervious surfaces within this watershed. Several areas within the Dogue Creek watershed are under consideration for future facilities construction. Such development would increase impervious surfaces, and contribute additional stormwater runoff (Landgraf, 1999).

Pohick Creek

The Pohick Creek watershed is in the southeast corner of the installation, in the undeveloped South Post training area. Fort Belvoir contains only 3% (699 acres) of the overall area (22,755 acres) of the Pohick Creek watershed as delineated by Fairfax County. Two subwatersheds of Pohick Creek are located on post (Figure 7.2, Table 7.4). Pohick Creek is the least developed of the three main Fort Belvoir watersheds. Pohick Creek originates just south of the City of Fairfax (Figure 7.1), and is tidally influenced up to the Old Colchester Road crossing at Fort Belvoir's western boundary. The watershed is experiencing development in the northern and eastern portions above Fort Belvoir. Within the installation, the Pohick Creek watershed has the lowest percentage of open area (4.24%), the second lowest percentage of impervious surface (0.5%), and the highest percentage of wetlands (19.97%) and forests (94.96%) (Landgraf, 1999).

Table 7.4: Fort Belvoir Watershed Survey – Pohick Creek

Subwatershed	*Size (acres)*	*Impervious Surface Acres (%)*		*Forest Acres (%)*		*Open Area Acres (%)*		*Wetland Acres (%)*	
45	458.51	3.51	(0.80)	424.64	(92.61)	28.36	(6.19)	87.11	(19.00)
46	240.40	0.05	(0.02)	239.07	(99.45)	1.28	(0.53)	52.46	(21.82)
Total*	**698.91**	**3.56**	**(0.50)**	**663.71**	**(94.96)**	**29.64**	**(4.24)**	**139.57**	**(19.97)**

Source: Landgraf, 1999.

*Total acreages (and percentages) under each land use/land cover category (i.e., impervious, forest, open area, and wetland) do not combine to equal the total acreage (100%) for the watershed because some areas of overlap exist.

According to the Fairfax County watershed data, the Pohick Creek watershed above Fort Belvoir has the highest number of water impoundments of the three watersheds that pass through Fort Belvoir. Approximately 10 ponds or lakes help slow the waters of Pohick Creek and its tributaries before the creek enters Fort Belvoir. Burke Lake Park, a Fairfax County park, is the largest of the impoundments with 213 acres of surface water. Burke Lake Park is located near the headwaters of South Run, the largest tributary of Pohick Creek (Landgraf, 1999).

The Norman M. Cole, Jr. Pollution Control Plant, formerly known as the Lower Potomac Pollution Control Plant, is a wastewater treatment facility located immediately adjacent to Fort Belvoir on Pohick Creek between Old Colchester Road and U.S. Route 1 (Figure 7.2). The facility receives approximately half of Fairfax County's domestic and commercial wastewater flow. The facility has a rated treatment capacity of 54 million gallons per day (MGD), and

discharges approximately 45 to 50 MGD into Pohick Creek. Variations in the discharge rate are due to fluctuations in water use and flow to the plant. The normal flow of Pohick Creek immediately prior to the point of the treated discharge is approximately 1 to 2 MGD, with close to zero flow during drought conditions (Faha, 2000). Therefore, the treatment plant discharge represents a substantial increase to the natural flow regime of Pohick Creek. The treatment plant operates under a Virginia Pollutant Discharge Elimination System permit, which is issued by the Virginia Department of Environmental Quality to Fairfax County, the plant operator. The plant achieves a 99 to 99.5% removal of suspended matter, organic substances, nutrients, infectious microorganisms, and other pollutants through preliminary, primary, secondary, and tertiary treatment (Fairfax County, 2000a).

Gunston Cove

The Gunston Cove watershed consists of areas on Fort Belvoir that drain directly from Fort Belvoir into Gunston Cove, without first entering Accotink Bay or Pohick Bay. It is one of the four watersheds that originate on post, and is completely contained within Fort Belvoir. Gunston Cove is a tidal waterway, and its watershed is comprised of seven subwatersheds on the installation totaling 681 acres (Figure 7.2, Table 7.5). Of the seven Fort Belvoir watersheds, the Gunston Cove watershed contains the second highest percentage of both impervious surface and open area (16.49% and 31.66% respectively). The watershed also contains the lowest percentage of wetlands (2.98%). The Gunston Cove watershed on Fort Belvoir is 51.85% forested (Landgraf, 1999).

Table 7.5: Fort Belvoir Watershed Survey – Gunston Cove

Subwatershed	*Size (acres)*	*Impervious Surface Acres (%)*		*Forest Acres (%)*		*Open Area Acres (%)*		*Wetland Acres (%)*	
8	14.83	2.45	(16.5)	8.26	(55.71)	4.12	(27.78)	0.31	(2.02)
9	30.56	1.51	(4.9)	23.31	(76.28)	5.75	(18.82)	1.35	(4.42)
10	78.31	5.36	(6.8)	57.29	(73.16)	15.66	(20.01)	2.47	(3.15)
11	251.62	45.51	(18.1)	125.34	(49.81)	80.77	(32.11)	8.86	(3.52)
12	12.28	2.44	(19.9)	3.79	(30.86)	6.05	(49.27)	0.59	(4.81)
13	44.59	9.37	(21.0)	16.49	(36.98)	18.73	(42.01)	1.71	(3.83)
14	248.38	45.58	(18.4)	118.41	(47.67)	84.41	(33.98)	5.02	(2.02)
Total*	**680.57**	**112.22**	**(16.49)**	**352.89**	**(51.85)**	**215.49**	**(31.66)**	**20.31**	**(2.98)**

Source: Landgraf, 1999.

*Total acreages (and percentages) under each land use/land cover category (i.e., impervious, forest, open area, and wetland) do not combine to equal the total acreage (100%) for the watershed because some areas of overlap exist.

Within the Gunston Cove watershed on Fort Belvoir, steeply graded tributary streams coming down from the upper plateau area are accelerating downstream gully and bank erosion. Sediment from the gully erosion is being deposited in the wetland area prior to Gunston Cove, particularly in subwatershed 11. This erosion can be attributed to heavy stormwater flows from the developed area on post south of 23rd Street along Putnam Road, Gridley Road, Kingman Road, and Burbeck Road. Subwatersheds 8, 9, and 10 face potential increases in stormwater runoff from future development of the Tompkins Basin Recreation Area. Subwatershed 12 contains a stable reach of

stream that can be used as a reference when making improvements to other first-order streams on post (Landgraf, 1999).

Accotink Bay

The Accotink Bay watershed consists of areas that drain directly from Fort Belvoir into Accotink Bay without first draining into Accotink Creek. The watershed originates on, and is completely contained within, Fort Belvoir. Accotink Bay is tidal, and receives drainage from five subwatersheds with a total area of 604 acres (Figure 7.2, Table 7.6). It has the highest overall impervious surface and open area percentages on the installation (18.58% and 42.13% respectively), making it a candidate for reforestation and reduction of impervious surface area. The watershed is 4.42% wetland, and contains the lowest percentage of forested land (45.35%) (Landgraf, 1999).

Table 7.6: Fort Belvoir Watershed Survey – Accotink Bay

Subwatershed	*Size (acres)*	*Impervious Surface Acres (%)*		*Forest Acres (%)*		*Open Area Acres (%)*		*Wetland Acres (%)*	
3	330.68	54.74	(16.60)	134.99	(40.82)	140.95	(42.62)	14.94	(4.52)
4	132.38	39.54	(29.90)	38.99	(29.45)	53.85	(40.68)	7.12	(5.38)
5	58.01	10.76	(18.60)	39.68	(68.41)	44.11	(13.05)	1.82	(3.14)
6	60.87	4.01	(6.60)	54.04	(88.79)	2.82	(4.63)	2.39	(3.93)
7	21.97	3.15	(14.30)	6.15	(27.99)	12.67	(57.67)	0.41	(1.87)
Total*	**603.91**	**112.20**	**(18.58)**	**273.85**	**(45.35)**	**254.40**	**(42.13)**	**26.68**	**(4.42)**

Source: Landgraf, 1999.

*Total acreages (and percentages) under each land use/land cover category (i.e., impervious, forest, open area, and wetland) do not combine to equal the total acreage (100%) for the watershed because some areas of overlap exist.

In addition to including a portion of the South Post golf course and other developed areas, this watershed includes part of the Accotink Bay Wildlife Refuge (ABWR) (Section 13). Subwatersheds 6 and 7 of the Accotink Bay watershed face potential stormwater increases due to the future construction of the Tompkins Basin Recreation Area. Subwatershed 4 has been identified by the watershed survey as the most problematic area due to the severity of gully erosion behind the Roads and Grounds Complex along 16th Street (Landgraf, 1999).

Pohick Bay

The Pohick Bay watershed consists of areas on Fort Belvoir that drain directly from Fort Belvoir into Pohick Bay, without first draining into Pohick Creek. The watershed originates on, and is completely contained within, Fort Belvoir. Pohick Bay is tidal and receives drainage from five subwatersheds with a total area of 566 acres (Figure 7.2, Table 7.7). The Pohick Bay watershed has the lowest percentage of impervious surface (0.01%) and the second highest percentage of forest (93.46%). The watershed on post is 5.50% wetland. Most of Pohick Bay's subwatersheds on post contain little or no impervious surface, and little or no open area (Landgraf, 1999).

Table 7.7: Fort Belvoir Watershed Survey – Pohick Bay									
Subwatershed	***Size (acres)***	***Impervious Surface Acres (%)***		***Forest Acres (%)***		***Open Area Acres (%)***		***Wetland Acres (%)***	
47	33.25	0.00	(0.000)	33.24	(99.97)	0.01	(0.03)	2.23	(6.71)
48	363.08	0.01	(0.003)	326.11	(89.82)	36.96	(10.18)	16.84	(4.64)
49	127.18	0.02	(0.015)	127.15	(99.97)	0.01	(0.01)	10.47	(8.23)
50	31.63	0.00	(0.000)	31.62	(99.97)	0.01	(0.03)	1.02	(3.22)
51	10.54	0.00	(0.000)	10.54	(100.00)	0.00	(0.00)	0.56	(5.31)
Total*	**565.68**	**0.03**	**(0.010)**	**528.66**	**(93.46)**	**36.99**	**(6.54)**	**31.12**	**(5.50)**

Source: Landgraf, 1999.

*Total acreages (and percentages) under each land use/land cover category (i.e., impervious, forest, open area, and wetland) do not combine to equal the total acreage (100%) for the watershed because some areas of overlap exist.

This watershed is in the undeveloped South Post training area, and includes part of the ABWR. The only developed features within the watershed are the unpaved training roads. Problem areas in the watershed are isolated and usually occur at culvert crossings on the training roads. Beaver activity is plugging a culvert within subwatershed 48. The blocked pipe is creating a check dam on the stream and the creek is cutting across a trail. The headwaters of this subwatershed are an open grass area that was formerly used as the impact and demolition area for the installation (training area 6) (Landgraf, 1999).

In contrast to most of the subwatersheds throughout Fort Belvoir, this watershed includes one subwatershed (designated number 48 in Landgraf (1999) (Figure 7.2), and UN-1 in EA (1999) that is considered to be stable and virtually unimpacted by development or land disturbance. This subwatershed is entirely within Fort Belvoir and, except for several unpaved training roads, has no development. The only water conveyances are the culverts underneath the training roads. The unnamed stream within this watershed, locally known as "Butterfly Stream", exhibits very little stormwater disturbance and is considered to be an exemplary example of a natural small-order stream in the Upper Coastal Plain of northern Virginia (Landgraf, 1999). Since examples of such natural watershed and stream conditions are virtually non-existent in this region, this subwatershed has been recommended as suitable for consideration as a reference stream when looking to improve other similar streams within this region (EA, 2000).

Potomac River

A small part of Fort Belvoir drains directly into the Potomac River without first entering Accotink Creek, Dogue Creek, Pohick Creek, Gunston Cove, Accotink Bay, or Pohick Bay. This watershed originates on, and is completely contained within, Fort Belvoir. The Potomac River watershed is comprised of five subwatersheds and has a total area of 237 acres, making it the smallest watershed on the installation (Figure 7.2, Table 7.8). The watershed is 14.24% impervious, 59.62% forested, and 4.34% wetland. Potomac River subwatershed 15 is the smallest subwatershed on post at slightly more than five acres, and is 100% forested (Landgraf, 1999).

Table 7.8: Fort Belvoir Watershed Survey – Potomac River									
Subwatershed	*Size (acres)*	*Impervious Surface Acres (%)*		*Forest Acres (%)*		*Open Area Acres (%)*		*Wetland Acres (%)*	
15	5.26	0.00	(0.0)	5.26	(100.00)	0.00	(0.00)	0.35	(6.65)
16	16.61	0.02	(0.1)	16.02	(96.45)	0.59	(3.54)	1.32	(7.95)
17	15.91	1.10	(6.9)	13.07	(82.15)	1.74	(10.94)	1.08	(6.79)
18	43.97	5.27	(12.0)	27.19	(61.84)	11.51	(26.18)	0.90	(2.05)
19	154.86	27.31	(17.6)	79.52	(51.35)	48.03	(31.01)	6.62	(4.27)
Total*	**236.61**	**33.70**	**(14.24)**	**141.06**	**(59.62)**	**61.87**	**(26.15)**	**10.27**	**(4.34)**

Source: Landgraf, 1999.

*Total acreages (and percentages) under each land use/land cover category (i.e., impervious, forest, open area, and wetland) do not combine to equal the total acreage (100%) for the watershed because some areas of overlap exist.

The Potomac River watershed also has the steepest stream gradients on the installation, with slopes as high as 60%. Three of the subwatersheds are relatively undeveloped due to the severe slopes above the Potomac River. Residential housing is located near two of the Potomac River subwatersheds (subwatersheds 18 and 19) that have severe erosion problems (Landgraf, 1999).

7.2.2 Aquatic Resources

7.2.2.1 Aquatic Studies

Information on water quality, and physical and biological conditions within Fort Belvoir aquatic systems is available through various surveys and studies (Table 7.9).

- A baseline aquatic inventory of Main Post and EPG (EA, 2000) was undertaken to characterize the installation's aquatic resources and provide management recommendations. The inventory addressed the installation's major perennial waterways: Accotink Creek, Dogue Creek, Mason Run, an unnamed tributary to Accotink Bay (designated in this study as UN-2) and an unnamed tributary to Pohick Bay (designated in this study as UN-1, and located within subwatershed 48 as described in Landgraf, 1999). Pohick Creek was not included because of the influence of the discharge from the Norman M. Cole, Jr. Pollution Control Plant immediately adjacent to Fort Belvoir. The baseline aquatic inventory consisted of field survey and sampling during three seasons: summer and fall 1998 and spring 1999. A second year of anadromous fish sampling and fish and benthic survey was conducted in 2000. The baseline inventory included the collection and analysis of basic water quality parameters, the sampling of fish (including anadromous fish) and aquatic invertebrates, and the development of habitat indices. The field survey design and analytic protocols were developed to facilitate statistical analyses, including long-term trend analysis. Data from the baseline aquatic inventory have been incorporated into the installation GIS.

- An inventory of fish species within Fort Belvoir's three major creeks was completed by George Mason University in 1994 (Ernst et al., 1995). The fish species inventory used field sampling to develop a fish species list, but did not provide population information.

This inventory included sampling locations in Pohick Creek, Pohick Bay, Accotink Creek, Accotink Bay, Gunston Cove, and Dogue Creek.

- An aquatic survey and habitat assessment was completed by George Mason University in 1997 (Jones and Kelso, 1999). The aquatic survey sampled fish and benthic macroinvertebraes in Pohick Creek, Accotink Creek and Dogue Creek in fall/winter 1995/1996 and spring 1997. The results of this survey included species lists, estimates of relative abundance, and habitat indices.

- A Natural Heritage Inventory of Fort Belvoir Main Post and EPG waterways was conducted by the Virginia Department of Conservation and Recreation Natural Heritage Program (DCR-NHP) to address the biodiversity of the installation's natural resources (Hobson, 1996; 1997). The purpose of the inventory was to systematically identify the installation's natural heritage resources, including those sites supporting unique or exemplary natural communities, rare species, and other significant natural areas. The survey surveyed aquatic plant and invertebrate species, but did not sample for fish. DCR-NHP in its inventory reports provided management recommendations to protect these species and their habitats. The results of this inventory have been incorporated into the installation GIS.

- Fish sampling of the two-acre Mulligan Pond was performed by the Virginia Department Game and Inland Fisheries (VDGIF) in early spring 1999 in support of the Mulligan Pond restoration project (unpublished data).

- George Mason University is performing long-term monitoring of Gunston Cove (e.g., Jones and Kelso, 1998) for Fairfax County. This monitoring addresses water quality, invertebrates, and fish in Gunston Cove and in Pohick and Accotink Bays. Monitoring results are reported annually to Fairfax County by George Mason University.

Table 7.9: Sources of Fort Belvoir Area Aquatic Resources Information

Agency	*Author*	*Survey Area*	*Information*	*Years*
U.S. Army Garrison Fort Belvoir	EA 1999, 2000	Accotink Creek, Dogue Creek, Mason Run, UN-1, UN-2	Benthic macroinvertebrates, fish (including anadromous fish), habitat, water quality	1998–2000
U.S. Army Garrison Fort Belvoir	Jones and Kelso 1998, 1999 (George Mason University)	Accotink Creek, Pohick Creek, Dogue Creek	Benthic macroinvertebrates, plankton, fish, habitat, water quality	1995–96
U.S. Army Garrison Fort Belvoir	Jones and Kelso 1998, 1999 (George Mason University)	Accotink Creek, Pohick Creek, Dogue Creek	Benthic macroinvertebrates, plankton, fish, habitat, water quality	1997
U.S. Army Garrison Fort Belvoir	Virginia Department of Game and Inland Fisheries 1999	Mulligan Pond	Fish	1999

Table 7.9: Sources of Fort Belvoir Area Aquatic Resources Information				
Agency	***Author***	***Survey Area***	***Information***	***Years***
		(continued)		
Fairfax County	Jones and Kelso 1996 (George Mason University)	Accotink Creek, Pohick Creek, Gunston Cove, Dogue Creek	Climate, water quality, plankton, fish (including anadromous fish), benthic organisms	1984 to date
U.S. Geological Survey (USGS)	Ator et al. 1998 (USGS)	5 miles upstream of EPG and 8 miles upstream of Fort Belvoir Main Post on Accotink Creek in Potomac River basin	Hydrology, environmental setting, water quality parameters (nutrients, pesticides, organics, metals, sediment), water quality ranking in a national context	1992–96 (Initial sampling period)
U.S. Army Garrison Fort Belvoir	Ernst et al., 1995	Accotink Creek; Pohick Creek; Dogue Creek below Mulligan Pond; and shorelines along Pohick Bay, Accotink Bay, Gunston Cove, and Potomac River	Fish	1994
U.S. Army Garrison Fort Belvoir	Dames and Moore, Inc., 1997	North Post Golf Course drainages	Water quality (nutrient and pesticide runoff)	1996-1997
U.S. Army Garrison Fort Belvoir	Hobson, 1996-1997 (DCR-NHP)	Main Post and EPG	Rare plant communities and species	1996-1997

7.2.2.2 Aquatic Conditions

Water Quality

As part of Fort Belvoir's baseline aquatic inventory (EA, 2000), water samples were collected during the summer of 1998 and spring of 1999 in all survey locations of the installation's five main perennial waterways: Accotink Creek, Dogue Creek, Mason Run, UN-1 and UN-2. The water samples were analyzed for nutrients, pesticides, metals, and total petroleum hydrocarbons. Sediment samples were not analyzed as part of this survey. Except for some metals (aluminum, manganese, iron), which had total metal concentrations higher than the U.S. EPA chronic aquatic life or human health criteria, none of the analytes measured were at high levels and some were not detected at all (i.e., pesticides). The U.S. EPA "human health" criteria for iron (300 µg/L) and manganese (50 µg/L) are based upon prevention of objectionable taste and laundry staining, not upon adverse toxicological effects. The chronic aquatic criterion for aluminum (87 µg/L) is based upon long-term exposures for striped bass, and is frequently exceeded in natural waters (EA, 2000).

Water quality sampling results of the Fort Belvoir baseline aquatic resources survey address base flow conditions rather than storm flows. They indicate that at the surveyed sections of the installation streams, base flow does not appear to be influenced by contaminant discharges (EA, 2000). It should be noted that Fort Belvoir's water quality sampling results do not address contaminant inputs from episodic events, such as stormwater flows.

The results of the USGS NAWQA program (Ator et al., 1998) provide an indication of the extent to which urbanization of the watersheds above Fort Belvoir negatively impacts local waterways. The NAWQA study was designed and undertaken to address water quality associated with stormwater flows. The NAWQA study of Accotink Creek (five miles upstream of EPG and eight miles upstream of Fort Belvoir) found the following:

- The largest loadings of total phosphorus per square mile and the most sediment per square mile among Potomac tributaries from which data were collected
- Pesticides in excess of aquatic life criteria in samples collected during periodic storm events in the summer months between 1992 and 1996
- The highest concentration of the insecticides Diazinon® and Malathion® measured in the Potomac River Basin
- The highest concentrations of the pesticides Oryzalins® and methyl chlorophenoxy acetic acid (MCPA) measured by the NAWQA Program nationwide.[3]

Stream habitat at the NAWQA Accotink Creek sampling site was among the most physically degraded in the nation as assessed by the NAWQA Program (Ator et al., 1998). This site was reported to exhibit examples of typical urban site habitat degradation, including lower bank stability, increased bank erosion, and lower densities of riparian vegetation than at less-degraded sites. Habitat quality is one of the primary factors influencing biological (i.e., fish, macroinvertebrate communities) condition in a waterway. The NAWQA study found moderate fish community degradation at the Accotink Creek sampling site. Overall, the results of the NAWQA Program indicate that Accotink Creek above Fort Belvoir is significantly impacted by urbanization (Ator et al., 1998).

The NAWQA Program does not have sampling sites on Dogue or Pohick Creeks, so comparable information is not available for those waterways. The watersheds of both creeks are considerably smaller (10,883 and 22,755 acres, respectively) than the Accotink Creek watershed (33,156 acres), and they have different drainage patterns than Accotink Creek. While the Dogue and Pohick Creek watersheds are influenced by urban land uses, neither is expected to experience the level of degradation reported for the section of Accotink Creek above Fort Belvoir at the present time. The large wetland area in Huntley Meadows Park can be expected to provide some moderation of stormwater flows in Dogue Creek above Fort Belvoir. Similarly, Pohick Creek above Fort Belvoir can be expected to be moderated by a series of regional stormwater ponds. Nonetheless, water quality and flow conditions in the lower reach of Pohick Creek adjacent to Fort Belvoir can be expected to be greatly influenced by discharge from the Norman M. Cole, Jr. Pollution Control Plant.

[3] The types of pesticides found at the NAWQA Accotink Creek sampling site are those generally used on rights-of-way, turf, golf courses, maintained landscapes, and as additives to asphalt and other building materials.

Physical Conditions

Fort Belvoir's baseline aquatic inventory characterized the physical habitat conditions along the five installation waterways surveyed (EA, 2000). The survey results described the lower reaches of the installation waterways as exhibiting typical upper Coastal Plain characteristics (e.g., slow moving, meandering, vegetated banks, predominated by runs with very little pool or riffle areas, in-stream snags and debris, shifting point/sand bars). Substrate composition, however, was described as being somewhat different than most Coastal Plain streams, having a higher proportion of gravel/cobble and a slightly lower amount of sand, most likely due to Fort Belvoir's location at the upper part of the Coastal Plain. The upper reach of Accotink Creek within EPG was described as having characteristics typical of Piedmont streams (e.g., steep gradient, rocky substrate, riffle habitat). Similarly, the tributary drainage network throughout Fort Belvoir's Main Post was described as exhibiting gradients in their upper reaches more typical to Piedmont streams. Physical habitat degradation (e.g., lower bank stability, bank erosion) was reported within virtually all of the installation's waterways surveyed. These conditions are related to the upstream urban effects of high stormwater flows discussed earlier. Significant erosion and bank instabilities were also reported in the smaller tributary drainages above the major waterways. Riparian forest buffers were reported to exist along both sides of most of the installation waterways (EA, 2000).

Benthic Community

The baseline aquatic inventory sampled benthic communities in Accotink Creek, Dogue Creek, Mason Run, UN-1, and UN-2 during the summer and fall 1998, and spring 1999 survey events. The results indicate a benthic macroinvertebrate community fairly typical of upper Coastal Plain streams, having lower diversity than would be expected from a Piedmont stream. Results showed a predominance of chironomid midge and oligochaete worm taxa, low numbers of the traditional sensitive taxa (i.e., EPT taxa – Ephemeroptera, Plecoptera, Trichoptera), but high numbers of Odonata, the dragonflies and damselflies that are the typical moderately sensitive taxa of low-gradient streams. This species composition indicates a benthic community tolerant of changing physical habitat conditions, as well as of variable water quality conditions. Taxa richness (total number of taxa), which is a measure of diversity in the benthic community, ranged from 14 to 52 taxa at any given site and season, and averaged between 25 to 29 (combined stations) with a total of 197 taxa collected during the baseline inventory (EA, 2000). The diversity and number of the benthic macroinvertebrates at Fort Belvoir is comparable to other Coastal Plain streams in the Mid-Atlantic region (U.S. EPA, 1997).

The baseline aquatic inventory reported seasonal variations in the benthic macroinvertebrate community in all but one of the waterways surveyed, with most of the indices being lower in the spring than in the summer or fall (EA, 2000). The greatest variations were reported at all the Accotink Creek locations, the downstream Mason Run station, and in UN-2. In contrast, UN-1, which has an entirely undeveloped watershed within Fort Belvoir (designated subwatershed 48 in Landgraf [1999]), was reported to have consistently high indices, with no seasonal variation. The Fort Belvoir area experienced drought conditions during the survey sampling period (summer and fall of 1998), followed by some significant winter rainstorms leading into the spring 1999 survey event. Stormwater flow from urbanized land uses may have influenced the benthic macroinvertebrate communities in Accotink Creek, Mason Run, and UN-2 (EA, 2000).

Fish Community

The fish survey component of the baseline aquatic inventory included multi-season (summer and fall 1998, and spring 1999) fish sampling (EA, 2000), as well as anadromous fish sampling in the spring 1999 (EA, 1999a) and again in spring 2000 (EA, 2000). The results of the baseline aquatic inventory (EA 1999a; 2000) together with results from the other Fort Belvoir aquatic studies (e.g., Ernst et al., 1995; Jones and Kelso, 1999) indicate a diverse fish community in Fort Belvoir waterways. A total of 57 fish species were identified in installation waterways (Appendix D, Table D.1) through these three survey efforts. An additional three species were identified in Gunston Cove through the long-term Fairfax County monitoring program, for a total of 60 fish species in the immediate Fort Belvoir locality.

The predominant groups of fish in Fort Belvoir waterways, both in numbers of species and in abundance are cyprinids (minnows) (*Hybognathus regius* and *Pimephales notatus*) and centrarchids (sunfish) (*Lepomus* spp.). These two groups typically dominate eastern North American waterways (Ernst et al., 1995). Other dominant fish species in Fort Belvoir waterways are banded killifish (*Fundulus diaphanus*), percids (perch, *Morone americana* and *Perca flavescens*) and American eel (*Anguilla rostrata*). Minnows comprise the majority of the fish in all installation waterways during spring and summer, while killifish dominate in the fall. Sunfish, perch and American eel are abundant year-round, as are blacknose dace (*Rhinichthys atratulus*), rosysided dace (*Clinostomus funduloides*), creek chub (*Semotilus atromaculatus*) and tesselated darter (*Etheostoma olmstedi*). Shiners (spottail, *Notropis hudsonius*) and spotfin (*Cyprinella spiloptera*) are among the abundant fish species during the summer (EA, 1998; 1999b,c; 2000).

Two species of river herring – alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) – are documented to migrate up Accotink Creek and Dogue Creek during the spawning season, although they do not appear to travel far up installation creeks (EA, 1999a; 2000). Alewives are the most abundant. Blueback herring were documented using installation creeks for the first time in 1999 (EA, 1999a). (Both are documented spawners in Gunston Cove [Jones and Kelso, 1998].) American and hickory shad (*Alosa sapidissima* and *Alosa mediocris*), while identified locally in the Potomac River, are more deep-water spawners and are not expected to occur in Fort Belvoir waterways. Gizzard shad (*Dorosoma cepedianum*), a semi-anadromous species, is another common spawner within Fort Belvoir waterways.

Long-term monitoring of Gunston Cove reveals the most abundant spawners to be river herring (alewife, blueback herring), gizzard shad, the semi-anadromous white perch (*Morone americana*) and various sunfish (Jones and Kelso, 1998). Gunston Cove is recognized as a rich nursery area for these species. White perch is the dominant fish species of Gunston Cove over much of the year. Other abundant species within Gunston Cove include channel catfish (*Ictalurus punctatus*), spottail shiner, bay anchovy (*Anchoa mitchilli*), brown bullhead (*Ameiurus nebulosus*), pumpkinseed (*Lepomis gibbosus*), tesselated darter, yellow perch (*Perca flavescens*), inland silverside (*Menidia beryllina*), mummichog (*Fundulus heteroclitus*) and golden shiner (*Notemigonus crysoleucas*) (Jones and Kelso, 1998).

The fish community in Fort Belvoir waterways is a diverse assemblage, which is characteristic of Coastal Plain streams. The species of fish identified in the Fort Belvoir waterways and in Gunston Cove are those that one would expect in this region. Natural conditions (large, slow moving upper Coastal Plain streams fed by a network of small, short reaching tributaries) dictate

that the species must be tolerant of warm water, low baseline flow, silty/sandy substrate, in-stream snags/debris, etc. Fishes in these waterways must also be tolerant of conditions (e.g., dramatic, ongoing in-stream and bank erosion, siltation, sedimentation, etc.) caused by excessive/unmoderated stormwater flows from developed land areas both on and off the installation, as well as chemical inputs from surrounding urban development. Pohick Creek, in particular, is strongly influenced by the discharge of the Norman M. Cole, Jr. Pollution Control Plant just outside the installation boundary. The fishes in these waterways are also subject to habitat changes caused by beaver activity. Nonetheless, the surveys did report that several species typical to Piedmont streams do occur in Accotink and Dogue Creek.

The smaller tributary streams surveyed during the baseline inventory reported a less diverse fish assemblage than that of the main installation waterways (EA, 2000). This is probably related to limitations in habitat availability (e.g., very small streams, lack of pools) in these small waterways, although there may be potential water quality problems influenced by stormwater or other inputs from the installation. A fish kill recorded in lower Mason Run in the fall of 1999 may be evidence of this problem or an unidentified isolated pollution event. The results of the baseline inventory indicated the occurrence of a viable and substantial anadromous fish migration (especially the herring and perches) up both Accotink and Dogue creeks (EA, 1999a; 2000).

There are no dams or obstructions within the three main creeks through Fort Belvoir, to prohibit anadromous fish passage up Pohick, Accotink and Dogue Creeks through the installation[4] (Figure 11.2). The small size and the intermittent flow conditions of most of the small tributaries on Fort Belvoir preclude all but the smallest fish species. At several locations on the tributary waterways, excessive sedimentation at the mouth of the tributary, or culvert blockages, appear to preclude all fish passage (EA, 2000).

UN-1 is unique for Fort Belvoir. This stream traverses a large undeveloped portion of Fort Belvoir and is not severely influenced by stormwater or other anthropogenic factors. The fish fauna of UN-1 contain healthy populations of American brook lamprey (*Lampetra appendix*). UN-1 is the only stream to yield eastern mudminnows (*Umbra pygmaea*) (EA, 1998; 1999b,c; 2000). Both of these species are indicators of good water quality and unaltered channels.

Fort Belvoir has very little permanent pond habitat. The only ponds (excluding beaver ponds) on post considered capable of supporting fish are (1) the less than one-acre pond at the North Post golf course; (2) the less than one-acre stormwater management pond at INSCOM; and, (3) the two-acre Mulligan Pond at JMAWR. Ernst et al. (1995) reported that these ponds had been stocked in the past with sunfish, perch, or black bass. An early spring fish survey of Mulligan Pond conducted in 1999 by the Virginia Department of Game and Inland Fisheries found gizzard shad (*Dorosoma cepedianum*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), common carp (*Cyprinus carpio*), and various sunfish (unpublished data). Neither of the other ponds have been surveyed within the past seven years.

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[4] There has been a passage problem on Dogue Creek, offsite at a culvert under U.S. Route 1 where obstructions may prohibit fish from freely passing through the culvert. In addition, a waterfall located approximately 50 meters upstream of the culvert inhibits fish movement into the wetland area above U.S. Route 1 and the rest of Dogue Creek.

None of the fish identified in Fort Belvoir waterways or ponds have federal or state threatened or endangered designations. The only such species identified in this region is the shortnose sturgeon (*Acipenser brevirostrum*), which occurs in the deeper waters of the Potomac River. This species is not expected to occur within Fort Belvoir waters. One state species of concern, the bridle shiner (*Notropis bifrenatus*), has been identified in several locations in Accotink and Dogue creeks. The bridle shiner was more abundant in Accotink Creek where it was collected in various types of habitat (EA, 2000). This species is found in quiet streams and creeks. It rarely enters tidal or brackish water.

Aquatic Habitat Assessments

Both the George Mason University (GMU) aquatic survey (Jones and Kelso, 1999) and the baseline aquatic inventory (EA, 2000) performed aquatic habitat assessments of Fort Belvoir waterways. These two assessments followed slightly different protocols, which resulted in variation between the two surveys' results. The protocol followed by GMU was a more generalized analysis, and used a reference stream from within a more Piedmont setting for comparison. In contrast, the baseline aquatic inventory followed by EA incorporated regional modifications more appropriate to Coastal Plain streams and to the Potomac River drainage system. Consequently, the GMU assessment is considered to have rated the installation's streams against a set of habitat standards uncharacteristic to this area, resulting in an exaggeration in the level of habitat degradation exhibited by these streams and their aquatic communities. The GMU assessment results, while useful to understanding in-stream conditions at Fort Belvoir, must be used with caution.

The GMU survey (Jones and Kelso, 1999) used the Rapid Bioassessment Protocol (RBP) for fish bioassessments to calculate an Index of Biological Integrity for aquatic communities, and used the Maryland Coastal Plain Macroinvertebrate Index for benthics. The GMU study assessed Pohick Creek, Accotink Creek and Dogue Creek within Fort Belvoir. The baseline aquatic inventory (EA, 2000) used the RBP approach, with regional modifications (U.S. EPA, 1997), and used the Coastal Plain Metric Index for benthic macroinvertebrates and fish. The baseline aquatic inventory assessed Accotink Creek, Dogue Creek and Mason Run (multiple locations on each stream), and UN-1 and UN-2 (one location on each) for the summer, fall, and spring survey events.

The GMU habitat assessment results (Jones and Kelso, 1999) indicated that Pohick, Accotink, and Dogue creeks were degraded, relative to the best streams in the Mid-Atlantic Coastal Plain. At the surveyed locations, GMU rated Accotink as poor to fair for fish and poor for macroinvertebrates. The survey reported that the "…observed degradation appears to be due mainly to activities upstream from Fort Belvoir. Pohick Creek was less degraded than Accotink Creek, even though the former received large quantities of treated effluent from the Norman M. Cole, Jr. Pollution Control Plant operated by Fairfax County. This suggests that nonpoint source pollution from suburban areas farther upstream is the prime degrading factor. This hypothesis is consistent with a stronger effect on Accotink [Creek], which is a larger and more heavily developed watershed than Pohick." (Jones and Kelso, 1999)

Table 7.10 presents a summary of the habitat ratings from the baseline aquatic inventory (EA, 2000). Within Accotink Creek, the upper survey locations (AC-1 and AC-2) tended to have higher overall habitat scores than the lower locations (AC-3 and AC-4) during all seasons. The

greatest differences were in the parameters for channel modification, instream habitat, pools (good to excellent at upper, good at lower) and bank stability (fair to good at upper, poor at lower). The lower stations had a lower diversity of runs and bends; and less snags, riffles, and vegetative and undercut banks. AC-3 also had less pool habitat. Dogue Creek had similarly variable scores between the two survey locations, mostly with regard to channel modification (excellent at upper, poor to fair at lower), pools (excellent at upper, good at lower) and bank stability (poor at upper, good at lower). The spring 1999 survey at the lower Dogue location (DG-3) exhibited impacts on vegetation, possibly as a result of construction activities for the Mulligan Pond renovation project and because of beaver impoundment. Within Mason Run, the lower survey location had slightly higher overall scores than the upper location during all seasons. The upper location had better bank stability (fair, compared to poor at the lower) and lower instream habitat and pools (good, compared with excellent at the lower). The two unnamed tributaries had the highest overall scores, with UN-1 having higher overall scores than UN-2. Both had consistently excellent ratings for channel modification, instream habitat, and good to excellent ratings for pools. UN-1 had the highest habitat score of any station within the study because of slightly better scores for many of the habitat parameters. This is a result of the absence of urban development in its entire watershed.

Table 7.10: Summary of Habitat Quality Evaluated at Fort Belvoir Streams†

	Summer 1998										
Habitat Parameters	***AC-1***	***AC-2***	***AC-3***	***AC-4***	***DG-1***	***DG-3***	***DG-4****	***MS-1***	***MS-2***	***UN-1***	***UN-2***
a. Channel Modification	16	16	12	15	18	7	N/A	17	18	18	18
b. Instream Habitat	13	16	11	14	17	17	N/A	14	16	17	17
c. Pools	17	17	11	15	17	14	N/A	15	17	17	16
d. Bank Stability											
Left	6	3	2	2	2	8	N/A	4	2	5	5
Right	6	3	2	2	2	8	N/A	4	2	5	5
e. Bank Vegetation Type											
Left	7	8	7	6	7	9	N/A	7	7	7	6
Right	7	8	7	6	7	9	N/A	7	7	7	6
f. Shading	12	16	16	16	15	16	N/A	14	15	17	16
g. Riparian Zone Width											
Left	10	10	10	10	10	10	N/A	10	10	10	10
Right	10	10	10	10	10	10	N/A	10	9	10	10
Total Score	**104**	**107**	**88**	**96**	**105**	**108**	**N/A**	**102**	**103**	**113**	**109**

Table 7.10: Summary of Habitat Quality Evaluated at Fort Belvoir Streams†

(continued)

Fall 1998

Habitat Parameters	*AC-1*	*AC-2*	*AC-3*	*AC-4*	*DG-1*	*DG-3*	*DG-4**	*MS-1*	*MS-2*	*UN-1*	*UN-2*
a. Channel Modification	16	16	12	13	18	5	N/A	16	17	18	17
b. Instream Habitat	16	17	13	13	17	15	N/A	16	17	18	17
c. Pools	15	17	12	16	16	12	N/A	12	16	14	14
d. Bank Stability											
Left	6	3	2	3	2	8	N/A	5	2	5	3
Right	6	3	3	3	3	8	N/A	5	2	5	3
e. Bank Vegetation Type											
Left	8	8	8	7	8	9	N/A	8	8	7	8
Right	8	8	8	7	8	9	N/A	8	8	7	8
f. Shading	16	16	16	16	15	16	N/A	14	15	17	15
g. Riparian Zone Width											
Left	10	10	10	10	10	10	N/A	10	10	10	10
Right	10	10	10	10	10	10	N/A	10	10	10	10
Total Score	**111**	**108**	**94**	**98**	**107**	**102**	**N/A**	**103**	**104**	**109**	**105**

Spring 1999

Habitat Parameters	*AC-1*	*AC-2*	*AC-3*	*AC-4*	*DG-1*	*DG-3*	*DG-4**	*MS-1*	*MS-2*	*UN-1*	*UN-2*
a. Channel Modification	16	18	11	14	17	5	N/A	16	17	17	16
b. Instream Habitat	14	17	14	15	16	15	N/A	16	17	16	16
c. Pools	16	18	12	16	16	11	N/A	12	15	14	12
d. Bank Stability											
Left	8	1	2	2	2	8	N/A	3	2	5	5
Right	7	1	1	2	2	8	N/A	3	2	5	5
e. Bank Vegetation Type											
Left	8	9	6	7	8	5	N/A	7	7	7	7
Right	8	8	6	7	8	6	N/A	7	7	7	7
f. Shading	12	16	16	16	16	10	N/A	10	10	10	10
g. Riparian Zone Width											
Left	10	10	9	10	10	10	N/A	10	10	10	10
Right	10	10	10	10	10	1	N/A	10	10	10	10
Total Score	**109**	**108**	**87**	**99**	**105**	**79**	**N/A**	**99**	**102**	**108**	**104**

Source: EA, 2000

† Because of habitat variations both within and among the waterways, care must be taken when comparing results for different waterways.

* Habitat assessment method not appropriate for stream type at DG-4.

Key to numerical ranges:

a, b, c, d	20-16 Excellent	15-11 Good	10-6 Fair	5-0 Poor
e, f, g	10-9 Excellent	8-6 Good	5-3 Fair	2-0 Poor

All of the survey locations assessed by the baseline aquatic inventory (EA, 2000) had excellent ratings for riparian width, and good to excellent ratings for shading and vegetation type, channel modification, instream habitat and pools. All of the survey locations exhibited some degree of habitat degradation related to bank stability. The most degraded conditions (poor rating) occurred at the lower Accotink Creek, upper Dogue Creek, and lower Mason Run survey locations.

Natural Heritage Resources

The natural heritage inventories (Hobson, 1996; 1997) identified four state rare plant species and four state watchlist plant species, all of which occur in wetland or aquatic habitats (Section 12). The natural heritage inventories also identified three federal or state-listed animal species, seven state rare animal species, and 13 state watchlist animal species, all of which inhabit wetland, riparian and/or aquatic areas (Section 12). The natural heritage inventories did not survey for fish.

7.3 WATER RESOURCES MANAGEMENT

7.3.1 Water Resources Conservation Recommendations

The water resources survey results for Fort Belvoir indicate that the aquatic systems on and through Fort Belvoir, while impacted by urbanization, have a high level of diversity and possess significant aquatic resources with high conservation priority (e.g., four state rare aquatic invertebrates, two river herring, American eel). The survey results indicate that nearly all of Fort Belvoir's waterways are being adversely impacted by on-post and off-post urbanization, mostly as a result of stormwater-related problems. The surveys warn that the situation may become worse as stormwater problems persist. As land development (both on-post and off-post) continues, and as stormwater flow excesses bring such problems as physical habitat loss or degradation due to erosion and sedimentation; water quality degradation due to transport of non-point source pollutants; benthic organism displacement due to excessive in-stream flows and channel scour; and impediment to fish passage due to improperly configured or blocked conveyances. As stream channel conditions degrade and bank instabilities worsen, the likelihood increases for these channel and bank instabilities resulting from flow problems to be "corrected" by hard engineered actions (e.g., channelization, hardened riprap, gabions, etc.), which would displace natural in-stream habitat.

The Fort Belvoir watershed survey identified approximately 1,740 in-stream problem sites (e.g., erosion, unstable channels, undermined structures) related to stormwater-management problems (Landgraf, 1999). The survey ranked the severity of the problems, and provided recommendations to correct the problems. Essentially, the watershed survey recommended an installation-wide program of corrective actions.

Fort Belvoir's *Watershed-based Stream Corridor Management and Protection Plan* (Allen et al., 1999) validated the specific types of in-stream problems at Fort Belvoir, their causes and the corrective actions recommended in the watershed survey report (Landgraf, 1999). The stream corridor management and protection plan then made recommendations for installation-level policy and for watershed-based stream corridor management strategies to correct existing problems and prevent future problems. The stream corridor management plan focused on

stormwater management within watersheds; erosion control within streams and drainageways; riparian buffer protection, restoration and maintenance; and fish and wildlife habitat protection. The management plan provided the following recommendations:

- Implement stormwater management protocols that require best management practices for new construction projects.
- Implement a drainageway maintenance program (e.g., maintenance of existing stormwater management structures).
- Implement a repair/renovation program (e.g., correction of nickpoints and headcuts) to correct erosion problems within streams and drainageways.
- Implement improvements to counter stormwater flow excesses from developed areas (e.g., removal of excess/abandoned pavement, addition of infiltration areas, and energy dissipation at outfalls).

The large number of problem sites identified in the watershed survey contrasts sharply with the fact that Fort Belvoir has preserved riparian buffers along virtually all of the installation streams. The watershed survey concluded that the problems resulted from "improper stormwater management and excess channel velocities, not natural erosive forces" (Landgraf, 1999). For problem streams, the stream corridor management plan (Allen et al., 1999) agreed with the watershed survey's conclusion, and cited the lack of drainage structure maintenance, inadequate riparian buffer width and excessive impervious surfaces as major contributing factors. Although current riparian buffers on Fort Belvoir are sufficient for most streams, the stream corridor management plan cites proposed on-post construction as a possible future compromise to riparian protection. To safeguard against impacts from future construction activities, the stream corridor management plan recommended that Fort Belvoir (1) assess the potential for future problems prior to undertaking construction; (2) take actions to avoid or minimize potential problems; and (3) adopt the guidelines listed in the plan for riparian buffer composition and width.

The results of the aquatic resources surveys (EA, 2000; Jones and Kelso, 1998) and the DCR-NHP Natural Heritage Inventory (Hobson, 1996) consistently cite the impact of present-day stormwater runoff on aquatic resources within installation waterways, and the need for stormwater management improvements to control these impacts.

The baseline aquatic inventory (EA, 2000) and the DCR-NHP Natural Heritage Inventory (Hobson, 1996; 1997) also recommended conservation of specific installation areas to protect regionally rare aquatic resources. EA (2000) recommended conservation of waterway UN-1 to protect a rare example of an undisturbed upper Coastal Plain stream. DCR-NHP (Hobson, 1996) recommended establishment of a large conservation area, to include the watersheds of important aquatic habitats in T-7, T-9 and W-4, which includes UN-1 and its entire watershed (Figure 8.2), to protect rare aquatic plant and invertebrate species.

7.3.2 Water Resources Multiple Use Requirements

Military Training and Testing Requirements

Fort Belvoir has two Reserve units with water-based training requirements: the 299th Engineer Company and the 464th Transportation Company. The 299th Engineer Company performs float bridge training. The 464th Transportation Company performs safety exercises, beach disembarkments, boat and equipment maintenance, boat operations, and load and unload operations. Both companies require marina facilities and access to open water areas. The 464th also requires access to beach areas for launching and landing trainings.

Outdoor Recreation Requirements

The principal outdoor recreation activities involving water resources at Fort Belvoir are fishing, boating, nature watching (e.g., bird watching) and nature art (e.g., outdoor photography). Each of these activities requires appropriate access to water resources, and the use and enjoyment of water resources by each type of activity is predicated on the water resources being in a "healthy condition." Boating requires engineered facilities in a shoreline area such as boat launch, boat slips and docks, and a marina building. Fishing, nature watching, and nature art require much simpler access facilities, such as hiking trails and fishing piers.

Environmental Education and Scientific Research and Study Requirements

Environmental education and scientific research and study require appropriate access to water resources, and the presence of "healthy" aquatic systems. Access facilities can be as minor as hiking trails, or could include boat launch facilities for marine research vessels. Educational use of and access to water resources could also entail the availability of on-site classroom and laboratory facilities.

Land Development and Facilities Maintenance Requirements

While not specifically addressed in the DoD and Army management policies (Section 7.1), land development and facilities maintenance must be considered as one of the multiple uses of installation lands and waters. This is especially true for Fort Belvoir, which as of 2000, supports more than 100 tenant organizations and approximately 2,070 housing units. Furthermore, short- and long-term planning, as expressed in the *Fort Belvoir Real Property Master Plan* (Woolpert, 1993a) calls for continued development to support new facilities. The siting, construction, maintenance and use of these facilities represent the most significant source of potential impact to water resources on Fort Belvoir. Mission support to the development of new facilities necessitates balancing the need for new and expanded facilities against the need for natural resources conservation.

Water resources can pose threats to the construction and use of installation facilities through flooding, poor drainage and erosion. Mission support regarding the protection of the installation's developed facilities requires siting and design decisions, and maintenance actions to avoid or minimize such risks.

7.3.3 Water Resources Management Actions to Date

Fort Belvoir manages its water resources in accordance with the resource conservation and multiple use requirements of DoDI 4715.3 and AR 200-3. Management actions to date have

prioritized balancing conservation of water resources with providing for military mission support and sustained multiple use of water resources. Fort Belvoir approaches water resources management on a watershed basis, consistent with the Chesapeake Bay Program agreements.

Fort Belvoir recognizes that to be effective, water resources management actions must be identified and undertaken at the watershed level. Implementing a watershed-based management strategy for Accotink, Dogue, and Pohick Creeks is complicated by the fact that their watersheds are mostly off-post, where they are not controlled by a single land-management entity. Consequently, the management actions for these watersheds must be undertaken through a cooperative program among the major land holders and land managers within each watershed. In contrast, implementation of a watershed-based management strategy for the four watersheds on Fort Belvoir that are completely contained within the installation—Pohick Bay, Accotink Bay, Gunston Cove, and Potomac River—is simplified by the fact that Fort Belvoir is the sole land holder for these watersheds.

Fort Belvoir recognizes that the first step in promoting regionally coordinated water resources management is for Fort Belvoir to (1) correct existing problems within the four watersheds that are entirely within the installation's control, and (2) protect the integrity of the least-disturbed installation subwatersheds (i.e., subwatersheds 47, 48, 49, 50, and 51). These corrective and protective actions will not only be locally significant, but they will demonstrate Fort Belvoir's stewardship commitment. They will also foster partnerships with Fairfax County and will serve as models of successful design and construction techniques.

7.3.3.1 Water Resources Conservation Actions

Fort Belvoir works to protect and enhance native aquatic biodiversity by conserving and enhancing native aquatic habitats, correcting and preventing stormwater-related problems, and protecting against overuse and misuse of aquatic resources (e.g., illegal fishing). To date, Fort Belvoir's water resources conservation actions have taken the following basic forms:

- Designating key installation areas (e.g., stream corridors and shorelines) as conservation areas
- Performing watershed improvements, including the following:
  - Implementing measures to control on-post stormwater
  - Implementing projects to correct stormwater-related problems and re-establish natural stream channel conditions downstream
  - Reducing excess impervious surfaces throughout installation watersheds
- Enhancing native habitat conditions within aquatic habitats on Fort Belvoir (i.e., within Mulligan Pond)

- Implementing and enforcing water resources protection regulations
- Coordinating water resources information and supporting water resources management at the regional level.

Each of these conservation actions is discusssed below.

Conservation Area Designation
Fort Belvoir has set aside for conservation three large blocks of ecologically significant installation areas by designating two installation refuges and the installation's Forest and Wildlife Corridor (Section 13). All of the Pohick Creek, Pohick Bay, lower Accotink Creek and Accotink Bay shorelines on post are included within the ABWR. All of the upper Dogue Creek stream corridor and Mulligan Pond are within the JMAWR. Sections of upper Accotink Creek and Mason Run are within the Forest and Wildlife Corridor.

The *Fort Belvoir Real Property Master Plan* (Woolpert, 1993a) designates the refuges, corridor, all wetlands, and all steep-sloped riparian areas as "environmentally constrained to development." The steep-sloped riparian areas include virtually all of the Potomac River and much of the Gunston Cove shorelines. This conservation designation effectively directs land-use development away from wetlands, riparian areas, and shorelines.

Stormwater Control
In 1999, Fort Belvoir began implementing a long-term program to correct existing stormwater-related problems, and prevent future problems, in accordance with the recommendations of Landgraf (1999) and Allen et al. (1999). This included incorporation of stormwater management facilities/considerations into all facilities construction projects. It also included projects to retrofit existing facilities with structures to control and moderate existing stormwater flows. Also in 1999, Fort Belvoir required two major construction projects to include BMPs and to follow the management recommendations of Allen et al. (1999). These projects were the new U.S. Army Reserve North Post facilities and the Virginia Department of Transportation (VDOT) widening of Telegraph Road through Fort Belvoir. Fort Belvoir required the U.S. Army Reserves to do the following:

- Modify the project grading plan to reduce stormwater impacts by re-directing runoff from existing eroded channels.
- Calculate the post-construction runoff conditions using a pre-construction scenario of no paved surfaces.
- Construct a stormwater pond sized sufficiently to accommodate stormwater from future development within that subwatershed.

In response to Fort Belvoir requirements, on the Telegraph Road widening project, VDOT committed to do the following:

- Use the services of their newly established team of hydrologic and environmental engineers (i.e., the "stream team") to modify the Accotink Creek bridge and channel design using natural stability concepts.

- Modify the culvert design for the Long Branch Creek crossing to correct stream bank erosion and promote natural maintenance of the watercourse to its confluence with Accotink Creek.

Stream Corridor Restoration

In 1999, Fort Belvoir began implementing projects to repair stormwater-related problems within installation stream corridors, in accordance with the recommendations of Landgraf (1999) and Allen et al. (1999). Such actions include in-stream corrections such as slope stabilization, riparian buffer enhancements, and the installation of new or the repair of existing stormwater control structures (e.g., energy dissipation and flow moderation devices). As of 2000, Fort Belvoir has initiated the following actions to correct in-stream problems identified by Landgraf (1999), as follows:

- Subwatershed 03 restoration, problem sites corrected along entire length

- Subwatershed 02 restoration, energy dissipation structures at outfall

- Subwatershed 01 restoration, outfall protection and channel repairs

- Subwatershed 04, corrections to upper reaches, including stormwater pond, rock check dam, and outfall protection

- Subwatershed 22 restoration, correction of problem sites along 1,000 linear feet of upper stream channel

- Subwatershed 38, re-establishment of natural stream channel conditions within the wildlife crossing structure under the Fairfax Parkway

- Subwatershed 11, removal of failed concrete channel and re-establishment of natural meandering channel conditions within the housing area (behind Quarter 172, Thermo-Con).

As of 2000, Fort Belvoir has undertaken four projects resulting in approximately 10 acres of riparian buffer enhancement. These projects included the following:

- Plantings along Dogue Creek, just above the Dogue Creek marina

- Plantings along waterways within the Fairfax County Parkway

- Plantings along tributaries of Accotink Creek, along U.S. Route 1

- Plantings along Mason Run.

Impervious Surface Reduction
Since 1999, Fort Belvoir has been identifying and removing abandoned pavement to reduce unnecessary impervious surfaces within installation watersheds. Areas where pavement has been removed are replanted with native trees. In 1999, Fort Belvoir removed 2.9 acres; in 2000, 1.5 acres. An additional 3 acres are identified for fiscal year (FY) 01 funding.

Aquatic Habitat Enhancement
The only aquatic habitats that belong to Fort Belvoir are the three installation ponds: the 2-acre Mulligan Pond in the JMAWR, the less than one-acre pond on the North Post Golf Course, and the less than one-acre stormwater pond on the INSCOM facility. With the exception of the Potomac River, all of the waterways that pass through or adjacent to Fort Belvoir belong to the Commonwealth of Virginia. The Potomac River belongs to Maryland. Consequently, Fort Belvoir's opportunities for manipulation of aquatic habitats are quite limited.

In 1999, Fort Belvoir undertook a complete renovation of Mulligan Pond to improve fish habitat. The project entailed correcting bank erosion, adding water control capabilities, planting riparian vegetation along the pond shore, installing fish habitat structures, and performing a one-time stocking of channel catfish. Fishing pressure is expected to exceed the pond's self-sustainability, and annual or periodic stocking is being considered to maintain a native, warmwater fishery.

Regional Coordination
Fort Belvoir has been working closely with Fairfax County to coordinate watershed GIS mapping. As of 2000, all Fairfax County watershed information has been incorporated into the installation GIS. Although the Fairfax County's watershed information has been incorporated into the Fort Belvoir's GIS, the installation's watershed mapping and characterization efforts are much more extensive than the County's.

Fort Belvoir's Special Agent provides support to federal and state agents on investigative and enforcement actions regarding water resources within the region.

7.3.3.2 Multiple Use Support

Military Training and Testing
The Fort Belvoir Training Regulation (FB 210-27) includes measures to protect waterways from impact by training activities. It requires that vehicles stay on established trails and roads, and that any damage to natural or artificial drainage is repaired by the using unit. The regulation restricts riot control agents to Training Areas T-6C, T-7, and designated areas of T-10, and requires training activities that use the agents to be kept 100 meters away from Pohick Creek and Pohick/Accotink Bay in these areas. All waste must be removed from the training areas and disposed of properly. The regulation requires ENRD review of all land disturbing training activities by application for an excavation permit.

As needed, ENRD provides technical support to military training and testing activities that involve water-based training. In 1999, ENRD performed Clean Water Act, Subaqueous Bed and Fairfax County Wetland permitting; Endangered Species Act consultation; and National Environmental Policy Act document preparation and public coordination for construction of the new U.S. Army Reserves marine facilities on Gunston Cove.

Outdoor Recreation

Fort Belvoir controls the types, locations and magnitude of recreational activities to ensure that such uses do not adversely affect water resources. All proposed recreational activities and events in, or potentially affecting, undeveloped lands or waters must be reviewed by ENRD for potential impact. Fort Belvoir's Supplement 1 to AR 200-3 (Appendix H) states that "[Anglers] and boaters are required to provide for environmental protection of all shoreline areas through restricting watercraft launching to designated marina launch facilities. Streambank clearing, littering, parking in other than designated areas, and driving of privately owned vehicles (POV) off primary installation roads[5] are prohibited." This applies to use requests from outside entities, as well as requests from installation organizations (e.g., Directorate of Personnel and Community Activities). The Fort Belvoir Supplement to AR 200-3 prohibits actions which could adversely affect natural resources within the installation's refuges, and requires anglers and boaters to provide for environmental protection of all shoreline areas. The supplement specifically prohibits boat launching and landing at any location other than at the installation marina, except for installation-sponsored events.

As needed, ENRD provides technical support to outdoor recreation events and facilities that involve water-based recreation. For example, ENRD is providing planning-level support, environmental assessment and regulatory compliance evaluation and coordination on the planned Tompkins Basin Recreation Area complex along Gunston Cove.

Fort Belvoir provides limited public access to installation shorelines and to Mulligan Pond for fishing, consistent with all applicable federal, state and regional fishing regulations. Areas open to the public for fishing include the ABWR shoreline, the Tompkins Basin shoreline (Gunston Cove), and the lower Dogue Creek shoreline. Fort Belvoir does not have an installation fishing permit program. During the 1999 renovation of Mulligan Pond, Fort Belvoir installed two fishing piers that are accessible to persons with disabilities. Fort Belvoir also has a pier along Gunston Cove that is available for use by anglers (this pier is not accessible to persons with disabilities).

Fort Belvoir performed a stocking of Mulligan Pond, after the 1999 renovation project, and is coordinating with state fisheries biologists regarding future stockings to manage a native warmwater fishery in the pond. As stated earlier, it is recognized that fishing pressure is likely to exceed the pond's ability to maintain a self sustaining warmwater fishery. Fort Belvoir is considering stocking on an annual or periodic basis to help maintain a native warmwater fishery.

It is not the installation's policy to manage the pond for a "put and take" fishery. It is installation policy not to stock Mulligan Pond, or any other installation water body, with non-native fish or other non-native aquatics.

Environmental Education and Scientific Research and Study

Fort Belvoir controls the types, locations and magnitude of environmental education and scientific research and study activities to ensure that such uses do not adversely affect water resources. All proposed recreational activities and events in or potentially affecting undeveloped

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[5] Primary installation roads are defined as paved roads and established training roads. POVs must be authorized to use training roads.

areas must be reviewed by ENRD for potential impact. This applies to use requests from outside entities as well as requests from installation organizations.

In 1999, Fort Belvoir initiated the installation's environmental education program. The Fort Belvoir environmental education program is based within the installation's refuge system (Section 13). Activities during the first year included development of age-specific environmental curricula; development of educational materials and displays; providing an environmental component as part of the installation's summer camp program; providing educational talks to school groups, scouting groups and others; and providing guided nature walks within the refuges. In 2000, Fort Belvoir expanded on these offerings, and opened the ABWR Environmental Education Center to provide indoor display and classroom space. The Fort Belvoir Environmental Education program pays major emphasis on water resources, and the installation's role within the Chesapeake Bay Program.

Land Development and Facilities Maintenance

Fort Belvoir includes water resources protection as a consideration in all land development decisions. The *Environmental Protection Specifications* for all construction projects include requirements for water resources protection. Installation siting, design, and construction actions involve ENRD as a reviewer. Similarly, the Fort Belvoir Policy Letter #420-26-00 *Excavation Work Permit Requirements and Procedures* (U.S. Army, 2000e) and the Fort Belvoir *Disposal Checklist* administered by the Directorate of Installation Support both require ENRD review.

As addressed earlier, Fort Belvoir has been incorporating BMPs into all construction projects. In 2000, Fort Belvoir began to work with the principles of low impact development (LID) to minimize the long-term effects of new developments on water resources. In developed areas with high impervious cover, excess stormwater runoff can create pollution and degrade natural aquatic communities. Principles of LID focus on soil conservation, runoff dispersion, water retention and treatment, groundwater recharge, and functional landscaping. Common LID practices include elements such as bioretention areas (such as rain gardens), strategic grading, parking lot curb cuts and detention, reduction of impervious surfaces, roof leader disconnects, and rain barrels.

In addition to LID techniques, Fort Belvoir has employed bendway weirs to stabilize a stretch of Accotink Creek. Bendway weirs are environmentally preferable alternatives to channelization for stream stabilization. A series of low-angled stone weirs are placed within the stream to redirect flow in a way that reduces riverbank erosion and channel deepening. These weirs are installed with minimal disturbance to the stream, and require no removal of vegetation. Fort Belvoir, as one of the first military facilities on the east coast to employ bendway weirs, has hosted a muti-agency training session on weir construction.

As needed, ENRD provides technical support to water quality permitting and regulatory compliance actions (e.g., National/Virginia Pollutant Discharge Elimination System permits, Virginia stormwater management regulations, Virginia sediment and erosion control regulations) on all land disturbing projects. In addition, ENRD provides annual training to installation BASEOPS, contractor, and U.S. Army Corps of Engineers construction management staff in compliance with the requirements of the Virginia sediment and erosion control regulations and the Virginia stormwater management regulations.

7.4 CONTINUING AND FUTURE WATER RESOURCES MANAGEMENT

Fort Belvoir intends to continue the management emphasis and actions addressed in Section 7.3. Fort Belvoir will continue to conserve and enhance native water resources, while providing balance among the multiple legitimate uses and users of Fort Belvoir's water resources. Continued support of military training and testing will take primacy. After that, management emphasis will be on conservation and enhancement of water resources in accordance with established DoD and DA natural resources management policies, and DoD and DA commitments to natural resource stewardship programs, such as the Chesapeake Bay Program. Fort Belvoir recognizes that the most significant threats to local water resources today arise from stormwater-related problems, well as misuse and overuse. Consequently, Fort Belvoir's conservation program will emphasize actions to correct and prevent stormwater-related problems, to restore damaged stream corridors, and to foster wise use of water resources. Fort Belvoir's natural resources management program will continue to promote public access to and appropriate use of water resources and will continue to provide the public opportunities for recreation and for environmental education and scientific research and study of water resources, consistent with resource conservation objectives. The natural resources management program will continue to pursue innovative approaches to water resources management, and will increase efforts toward and involvement with regional water resources management actions.

7.4.1 Water Resources Management Objectives

1. Protect against loss or degradation of native diversity of aquatic resources, as defined by EA (1999a, 2000); Ernst et al. (1995); Jones and Kelso, (1998, 1999), and Hobson (1996, 1997).

2. Conserve and enhance water resources that have been prioritized for conservation by the Chesapeake Bay Program, the Virginia Natural Heritage Program, and the American Heritage Rivers Program. These include the following:

    a. Anadromous and other migratory fish. As of 2000, Fort Belvoir has three species of management emphasis, alewife, blueback herring, and American eel that migrate up installation waterways.

    b. Endangered, threatened, and rare aquatic species and their habitats. As of 2000, Fort Belvoir has several such species that inhabit aquatic and/or wetland habitats (Section 12.2).

3. Protect, enhance, and restore native aquatic habitat conditions by correcting existing stormwater-related problems, and preventing future stormwater-related problems as recommended by Landgraf (1999), Allen et al. (1999), and Hobson (1996), and by adopting innovative approaches to managing stormwater-related issues (e.g., following the principles of LID).

4. Maintain Mulligan Pond as a healthy, sustainable native warmwater fishery.

5. Protect UN-1 as an undisturbed waterway.

6. Provide opportunities for public access for recreation and for environmental education, and study consistent with resource conservation.

7.4.2 Water Resources Management Strategies

1. Continue to obtain scientific information on installation water resources to support knowledge of the biodiversity of aquatic communities, to identify stresses and detect changes to biodiversity, and to evaluate the effectiveness of management actions.

   - Complete the next installation-wide aquatic inventory update on a 5-year cycle (in FY 04). The inventory will entail field survey and sampling, and GIS datalayer development. The field survey will address fish, including anadromous and other migratory fish, benthics, and water quality and habitat conditions. The previous inventories will be maintained in such a way that allows for comparison among inventories, and will allow the installation to establish trends.

   - Continue to perform annual in-stream monitoring of fish and benthic communities consistent with the protocol established by the baseline aquatic inventory (EA, 2000).

   - Develop and implement annual fish monitoring of Mulligan Pond. Explore the possibility of having the Mulligan Pond monitoring performed by Virginia Department of Game and Inland Fisheries (VDGIF).

   - Perform year-round surveillance (i.e., close observation, in lieu of studies or monitoring projects) of aquatic systems to detect disruptions and/or locations where threats (e.g., sedimentation) are affecting resource integrity. At a minimum, surveillance will address physical habitat conditions and may include some biological sampling and in-situ water quality measurement. Depending upon resource availability and need, more-elaborate sampling or surveys (e.g., hydrologic monitoring or modeling) may be conducted. Maintain the results in the GIS.

   - Perform localized and/or issue-specific water resources studies/monitoring as needed to support resource management or for specific installation projects, such as new development.

   - Coordinate with other entities performing aquatic studies and management actions in the Fort Belvoir area. These include the long-term aquatic resources monitoring of Gunston Cove being performed by George Mason University for Fairfax County.

   - Complete the next installation-wide watershed inventory update on a 5-year cycle (in FY 04). The inventory will entail field survey, photo-interpretation, land-cover analysis, and GIS datalayer development. The previous inventories will be maintained in such a way that allows for comparison among inventories, and allows the installation to establish trends in land use and land cover. The results will be maintained in the GIS.

   - Perform an annual survey (addressing sedimentation, erosion, water quality, etc.) of a representative sample of installation waterways to assess changes within the stream

corridors, and evaluate the success of management/corrective actions (i.e., the annual watershed monitoring). Prepare an annual report and update the GIS datalayer to record corrective actions undertaken. Maintain the results in the GIS.

- Identify the 100-year floodplain boundaries on post. Incorporate the floodplain boundaries into the GIS. Coordinate with Fairfax County to obtain the results of their floodplain determinations for the Fort Belvoir area.

- Incorporate the boundaries of Fairfax County's Resource Protection Area into the GIS.

- Complete the Fort Belvoir hydrography datalayer. Coordinate with the USGS and the U.S. Army Corps of Engineers to validate the determinations of "perennial" and "intermittent" waterways on post.

- Perform an historic waterways and shoreline delineation and trend analysis to detect change. Obtain historic aerial photography at a minimum of one flight per decade from 1930 to date, and interpret the locations of the waterways and shorelines on post. Maintain the historic waterway and shoreline analysis as individual files on the GIS to allow for comparison among years.

- Coordinate with VDGIF, DCR-NHP, Northern Virginia Soil and Water Conservation District, Chesapeake Bay Program Office, and other appropriate entities regarding stewardship recommendations for water resources.

2. Continue to set aside areas of ecologically significant water resources, consistent with DoD policy for setting aside areas for conservation as "Special Natural Areas" (Section 13). As of 2000, Fort Belvoir has three such areas: two refuges and the Forest and Wildlife Corridor. Consider modifying the boundaries of the refuges and/or establishing a buffer for the refuges, to protect the watershed areas for significant water resources identified through the various installation water resources surveys and studies. Emphasize protection of the UN-1 watershed and any boundary modifications. Continue to designate these set-aside areas as "environmentally constrained to development" in the installation Master Plan.

3. Continue to maintain a riparian buffer along all installation waterways and shorelines consistent with the Chesapeake Bay Program Riparian Buffer Directive and the 1998 *Federal Agencies Chesapeake Ecosystem Unified Plan*.

   - Define the riparian buffer width for all installation waterways based on land management objectives and on the three-zone concept as recommended by Allen et al. (1999). Delineate the riparian buffer in the GIS.

   - Review the Fort Belvoir Master Plan's (Woolpert, 1993a) mapping of "environmentally constrained areas" where they are delineated along shorelines and stream corridors to ensure that the newly established riparian buffer widths are included within the constrained area designation. Develop a recommendation for revision of the Master Plan to incorporate the newly-established riparian buffer designations into the Master Plan's environmentally constrained areas, if necessary.

- Continue to protect riparian buffers from tree-clearing and vegetation removal.

- Continue to re-plant or enhance native vegetation within riparian buffer areas. Example projects include:
  - Reforestation of a minimum 200-foot wide riparian zone on the former petroleum, oil, and lubricant site along Gunston Cove
  - Riparian plantings along the Tompkins Basin shoreline, consistent with the planning for a multi-purpose recreation area at that site
  - Enhanced riparian planting along Dogue Creek above the Mount Vernon Road bridge, consistent with the planning for the Potomac Heritage National Scenic Trail at that location. Additional planting projects will be identified and undertaken as land-use changes (e.g., as old areas are vacated and structures are removed) allow.

- Continue to protect riparian buffer areas by directing water-based training activities (military and civilian) to designated shoreline facilities.

- Continue to protect riparian buffer areas by directing water-based recreational activities to designated public access shoreline areas. Prevent damage from public access in these areas by providing specific protected access points for foot traffic and specific parking facilities within those areas. Continue to limit shoreline access within the refuges to foot traffic only. Design specific public access features for the Tompkins Basin shoreline to facilitate rehabilitation of a vegetated shoreline in this area.

- Enforce the Fort Belvoir Supplement to AR 200-3 prohibitions on boat launching and landings, and on off-road vehicle (which includes bicycles) use, to protect riparian areas from these potentially damaging activities. Develop and install signs along installation shorelines indicating "no boat launching and landing." Develop and install educational displays on shoreline protection.

4. Continue to correct existing stormwater-related problems as recommended by Landgraf (1999) and Allen et al. (1999). Continue the long-term stream corridor restoration projects (also known as watershed restoration projects) begun in 1999. Address at least two subwatersheds each year.

5. Continue to implement actions to counter existing stormwater flow excesses from developed areas, as recommended by Allen et al. (1999). Such actions include the following:

   - Identify excess and abandoned pavements. Develop a phased plan for removal and replanting. Develop this as a GIS data layer. Implement plan to remove excess and abandoned pavements, and replant these areas.

   - Replant disturbed areas with native vegetation

   - Develop and construct a demonstration project for bioretention.

- Add energy dissipation structures at outfall points where problem areas were identified by Landgraf (1999).

6. Develop a program for routine drainageway maintenance, to include maintenance of existing stormwater structures. Such a program should include routine surveillance of conditions within installation drainageways, as well as the condition of all existing stormwater structures. The maintenance program should include routine structure clean-out (e.g., debris clearing from culverts) as well as repair and renovation of existing facilities. The repair and renovation planning should incorporate site-specific corrective action recommendations from Landgraf (1999). Develop a recommendation for a stormwater management working group comprised of representatives from ENRD, the Contract Management Division, and the base maintenance contractor and/or other requirements contractors, as appropriate to review and schedule routine inspection, cleaning, maintenance and repair/replacement of stormwater structures.

7. Continue to implement stormwater management actions, including BMPs, on all construction projects, as recommended by Allen et al. (1999).

8. Incorporate the principles of low impact development (LID) in facility siting and design on post, as recommended within the National Guidance Manual for Low Impact Development. Develop and maintain a LID Policy Letter to use percent impervious surfaces as thresholds for including LID features in project design.

9. Continue to use the installation project/activity review process to incorporate water resources conservation requirements into all phases of facilities siting, construction, renovation, operation, maintenance, and demolition activities; in reviewing and supporting military training and testing activities; in reviewing and responding to outdoor recreation, environmental education, scientific research and study; and all other types of land and water access and use requests.

    - Continue to issue the annual Fort Belvoir Tree Protection Policy Letter to stress preservation of trees and replacement of unavoidable loss of trees due to construction or due to natural causes, such as storm damage, insects or disease. Continue to require all tree removals to be reviewed and approved by ENRD, and replaced at a minimum two-to-one ratio.

    - Review and revise as needed the Fort Belvoir *Environmental Protection Specifications* applicable to construction projects to ensure that they include water resources protection provisions.

    - Review and revise, as needed the *Fort Belvoir Environmental Checklist* to address water resources protection.

    - Develop recommendations to revise the Installation Design Guide and the Fort Belvoir Master Plan to include site planning and construction design that minimizes natural area loss; adopts low impact development and BMPs for stormwater management, and sediment and erosion control; and reduces impervious surfaces.

- Incorporate water resources protection strategies into utilities privatization, and all other privatization and outsourcing actions, as appropriate.

- Develop recommendations for a facilities siting/design review committee to include representatives from ENRD, Master Planning, and the Contract Management Division. The committee should develop and participate in a siting/design review process to ensure the consideration of water resources protection in all facilities siting and design decisions.

- Continue to include water resources protection as part of the Excavation Permit and Demolition Permit review processes.

- Continue to include water resources protection in all real estate actions (e.g., outgrants, leases, rights of entry) as appropriate.

- Review and revise as needed the Fort Belvoir Training Regulation to address water resources protection.

- Develop and issue a Fort Belvoir Stormwater Management Policy Letter that requires all construction projects to include stormwater management planning, regardless of the size of the construction area. The policy letter will require compliance with the Virginia Sediment and Erosion Control Handbook (VA DCR, 1992), and will require stormwater management to be addressed for both the construction and post-construction periods. The policy letter will also address the principles of low impact development.

10. Continue to provide annual training in sediment and erosion control, and in stormwater management requirements and techniques to BASEOPS, contractor and tenant personnel, as appropriate. Identify and provide opportunities for specialized training in innovative water resources management techniques.

11. Continue to perform agency coordination, notification and permitting on installation actions involving water resources.

    - Continue to coordinate with the U.S. Fish and Wildlife Service under the Fish and Wildlife Coordination Act.

    - Continue to coordinate with VDGIF for compliance with Virginia Administrative Code 4 VAC 15-20 et al., governing Virginia game and non-game requirements, including endangered species mandates.

    - Continue to coordinate with the U.S. Army Corps of Engineers and the Virginia Department of Environmental Quality for compliance with the Clean Water Act and its implementing regulations, and Section 10 of the Rivers and Harbors Act.

    - Continue to coordinate with the Virginia Marine Resources Commission for compliance with Virginia Subaqueous Bed Regulations.

- Continue coordination with the Virginia Soil and Water Conservation Board for planning under the Virginia Erosion and Sediment Control Law (Section 10.1-560 of the Code of Virginia).

- Coordinate with the Chesapeake Bay Local Assistance Board for compliance with the Chesapeake Bay Preservation Act.

12. Continue to manage Mulligan Pond as a native, warmwater fishery.

    - Coordinate with VDGIF regarding providing support to Fort Belvoir in the removal of undesirable fish species and the stocking of native fish species.

    - Develop and implement fish habitat improvements at Mulligan Pond to improve fish habitat. Correct bank erosion, add water control capabilities, plant riparian vegetation along the pond shore, and install fish habitat structures.

    - Develop and implement measures as needed to protect shoreline plantings at Mulligan Pond from damage/loss to beavers.

13. Develop and issue a Fort Belvoir Fishing Policy Letter to address protection of water resources from fishing activities. Among other things, the policy letter will include measures to prohibit the use and release of exotic bait species.

14. Develop and participate in partnerships for water resources conservation. Address watershed management, point and nonpoint source runoff, stormwater management, fisheries management, invasives/exotics management, public access, and environmental education. Begin by coordinating with Fairfax County on its stormwater planning and stream protection programs.

15. Participate in annual events such as Potomac River shoreline clean-up days.

16. Evaluate areas where piers, ramps, boardwalks, and other structures can be built to enhance fishing access for people with disabilities.

17. Continue to provide technical assistance to emergency situations, such as fuel spills, that threaten aquatic resources, as needed.

18. Continue to respond to requests for technical information from on-post and off-post entities, as appropriate.

19. Continue to investigate and enforce violations of federal and state laws and regulations, as well as DoD, DA, and Fort Belvoir policies.